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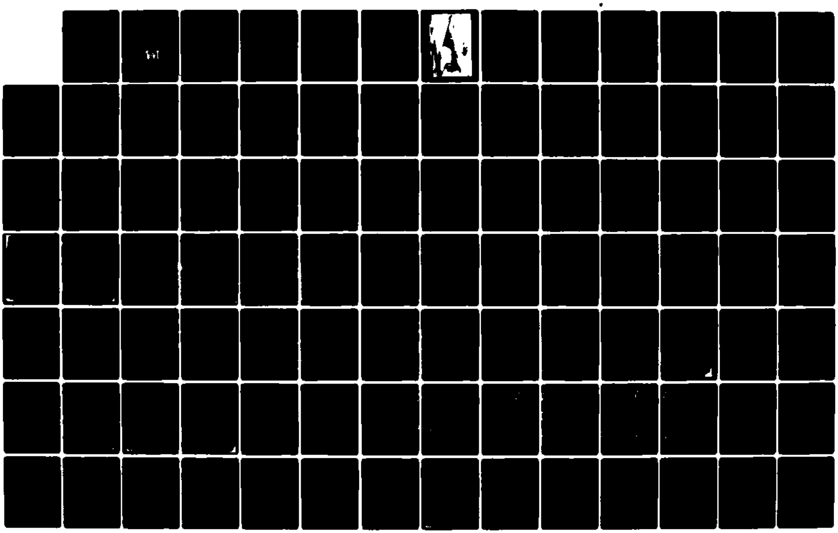

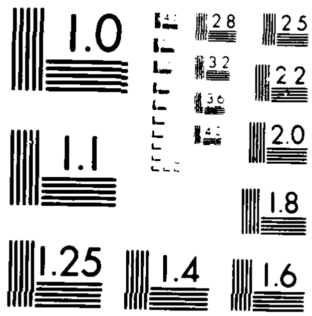


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# CAESAR CREEK LAKE

## LITTLE MIAMI RIVER BASIN

## OHIO

# EMBANKMENT CRITERIA AND PERFORMANCE REPORT





PREPARED BY
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS

SEPTEMBER 1982

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9 December 1982

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## REPORT DOCUMENTATION PAGE

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Site Geology
Construction Notes
Foundation-Abutment Treatment
Slope Stability
Diversion-Closure
Compaction Test Results
Shear Test Data
Seepage Control
Operational Notes
Instrumentation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The embankment criteria and performance report provides a summary record of significant design data, design assumptions, design computations, specification requirements, construction equipment, construction procedures, construction experience, field control and record control test data and embankment performance as monitored by instrumentation during construction and during initial lake filling.

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CAESAR CREEK LAKE
OHIO RIVER BASIN
OHIO

# EMBANKMENT CRITERIA AND PERFORMANCE REPORT

Prepared By
U. S. Army Engineer District, Louisville
Corps of Engineers
October 1982

Aerial View of Caesar Creek Lake

CAESAR CREEK LAKE, OHIO

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

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CAESAR CREEK LAKE

OHIO RIVER BASIN

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

## Pertinent Data

1. Authority for Project. Flood Control Act designated as Public Law 861, approved on 28 June 1938 as recommended by First Session, 75th Congress.

2. Purpose of Project. To furnish flood protection in the valley of Caesar Creek and Little Miami River Basin. The reservoir project is a unit in the general comprehensive plan for flood control and allied purposes in the Ohio River Basin. A secondary purpose of the project is to provide storage for water supply, land water quality control and a pool for recreation and fish and wildlife activities.

3. Location of Project. The dam is located on Caesar Creek about 3 miles above the junction with the Little Miami River and about 3.5 miles southeast of Waynesville, Ohio. It is located about 30 air miles northeast of Cincinnati, Ohio and 35 miles southeast of Dayton, Ohio.

4. Drainage Area at Damsite. 237 square miles.

5. **Reservoir.**

| Item | Elevation (feet msl) | Area (Acres) | Storage Acre feet | Storage Inches Runoff |
|---|---|---|---|---|
| Siltation Reserve | 800 | 700 | 13,300 | 1.05 |
| Water Supply and Water Quality Control | 846 | 2,720 | 93,700 | 7.41 |
| Seasonal Pool | 849 | 2,830 | 102,000 | 8.07 |
| Flood Pool | 883 | 6,110 | 242,200 | 19.16 |
| Allocated to Flood Storage | 846-883 | - | 148,500 | 11.75 |
| Allocated to Water Supply and Water Quality Control | 800-846 | - | 80,400 | 6.36 |
| Allocated to Seasonal Storage | 846-849 | - | 8,300 | 0.66 |
| Allocated to Seasonal Flood Storage | 849-883 | - | 140,200 | 11.09 |

6. Dam.

a. Embankment.

| | |
|---|---|
| Type | Earth & Rockfill |
| Top Elevation (msl) | 903 |
| Maximum Height, feet | 166 |
| Length, feet | 2,748 |
| Top width, feet | 42 |
| Side Slopes - Upstream | IV on 3.5H |
| - Downstream | IV on 3H |

b. Dikes.

| | |
|---|---|
| Number | 4 |
| Type | Earth Fill |
| Top Elevation (msl) | 903 |
| Maximum Height, feet | 'A'67, 'B'26, 'C'7, 'F'13 |
| Length, feet | 'A'5873, 'B'4054, 'C'605, 'F'977 |
| Top Width, feet | 12 |
| Side Slopes - Upstream | IV on 3H upper 14 ft<br>IV on 4H remainder |
| - Downstream | IV on 3H upper 14 ft<br>IV on 4H remainder |

c. Spillway.

| | |
|---|---|
| Type | Open Cut through left abutment ridge |
| Crest Elevation (msl) | 883 |
| Bottom Width, feet | 500 |
| Protection for Spillway Cut | 22′ Concrete sill at crest |
| Length, feet | 2,660 |
| Side Slopes | 1 on 3 overburden (10 foot berms) 2 on 1 rock |
| Bottom Slope | 0.5% upstream 1.5% downstream |

d. Outlet Works.

| | |
|---|---|
| Conduit Type | oblong, concrete |
| Conduit diameter, feet | 12′ high x 8′ wide |
| Control gates, number | 2 service, 2 emergency |
| Size of gates, feet | 4.00′ x 12.00′ |
| Invert Elevation to outlet works (msl) | 739 |
| Discharge Capacity at Minimum Pool(cfs) | 3,360 |
| Discharge Capacity at Seasonal Pool(cfs) | 4,480 |
| Discharge Capacity at Flood Pool(cfs) | 5,130 |

7. Land Acquisition.

Fee, Acres 11,100

8. Relocations.

a. State Highways.

| | |
|---|---|
| Ohio 380 | 2.38 miles |
| Ohio 73 | 1.40 miles |

b. County Roads.

| | |
|---|---|
| Greene County, 2 locations | 1.5 miles |
| Clinton County, 2 locations | 0.8 miles |
| Warren County, miscellaneous work | |

c. Public Utilities.

High Voltage electric power transmission lines

Medium Voltage electric power distribution lines

Telephone facilities and lines

Gas transmission pipe lines

9. Public Access.

Number of sites 4

10. Reservoir Clearing.

| | |
|---|---|
| Area, acres | 400 |

11. Hydroelectric Power. None

12. Annual Charges. $1,414,000

13. Annual Benefits.

| | |
|---|---|
| a. Flood Control | $1,244,000 |
| b. Recreation | 1,724,000 |
| c. Water Quality Control and Water Supply | 424,000 |
| Total | $3,392,000 |

14. Ratio, Benefits to Cost. 2.4 to 1

15. Construction Time. 3-1/2 years

CAESAR CREEK LAKE

OHIO RIVER BASIN

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

1. General.

a. Authority. Authority for preparation of the Embankment Criteria and Performance Report for Caesar Creek Dam is contained in ER-110-2-1901, dated 1 August 1972.

b. Project Purposes. To furnish flood protection in the valley of Caesar Creek and Little Miami River Basin. The reservoir project is a unit in the general comprehensive plan for flood control and allied purposes in the Ohio River Basin. A secondary purpose of the project is to provide storage for water quality control and a pool for recreation and fish and wildlife activities.

c. Project Location. The project is located on Caesar Creek about 3 miles above the junction with the Little Miami River and about 3.5 miles southeast of Waynesville, Ohio. It is located about 30 air miles northeast of Cincinnati, Ohio and 35 miles southeast of Dayton, Ohio. A reservoir area map and general plan are presented on Plates 1 and 2.

d. History of Construction. Contract DACW27-72-C-0086, Construction of Outlet Works, Dam, and Spillway, Caesar Creek Lake, Ohio, was awarded on 1 March 1972 to Butt and Head, Inc., Dayton, Ohio. The contract involved construction of the earth and rockfill dam, outlet works at the base of the right abutment, uncontrolled spillway on the left abutment, and all appurtenant work.

On 19 July 1973, the Attorney General of Ohio filed a complaint in the Federal District Court. As a result of this litigation, all significant work at the project was stopped by Court's Order on 24 July 1973 pending the filing of a complete and adequate Environmental Impact Statement. The restraining order was partially lifted to allow work to continue on the

permanent cofferdam and operating tower. The court injunction was vacated in May 1974.

The following is a compilation of significant contract dates:

| | |
|---|---|
| 04 April 1972 | First clearing begins. |
| 17 August 1972 | First concrete placed. |
| 23 March 1973 | Completed concrete work on conduit. |
| 25 May 1973 | Began stripping for permanent cofferdam. |
| 14 July 1973 | Stream diverted through conduit. |
| 21 July 1973 | Diversion cofferdam overtopped. |
| 24 July 1973 | Diversion cofferdam overtopped. |
| 25 July 1973 | Contractor informed of injunction against earth work. |
| 10 September 1973 | Work suspended by court--all work after 1100 hours directed towards preventing damage during winter |
| 11 September 1973 | Work suspension lifted--work limited to permanent cofferdam and spillway. |
| 02 November 1973 | Completed Stage I cofferdam. |
| 06 November 1973 | Began excavating cutoff trench. |
| 14 November 1973 | Completed Stage II cofferdam. |
| 07 December 1973 | Began grout operations through valley. |
| 27 December 1973 | Completed grout in valley. |
| 23 May 1974 | Contractor informed that injunction had been totally lifted. |
| 20 August 1974 | Began cleaning cutoff trench. |
| 07 September 1974 | Core trench cleaned, inspected and impervious placement begun. |
| 17 September 1974 | Began placing rock. |
| 25 October 1974 | Began excavating right abutment cutoff trench. |
| 06 November 1974 | Began grouting right abutment. |
| 14 November 1974 | Grouting complete. |
| 19 November 1974 | Excavation for toe drain. |
| 06 December 1974 | Toe drain complete. |
| 16 December 1974 | Winter shutdown for major embankment with fill at elevation 783$\pm$. |
| 03 April 1975 | Began embankment. |
| 06 May 1975 | Start placing riprap on US slope. |
| 09 August 1975 | Dam topped out. |
| 25 August 1975 | Began piezometer installation. |
| 11 October 1975 | Piezometers complete. |
| 13 October 1975 | Spillway control structure finished. |
| 12 December 1975 | Installed surface reference marks. |

2. Geology.

a. Project Area. The Caesar Creek Reservoir site is located in the glaciated area of Ohio. Glacial deposits are Illinoian and Wisconsian in age. The damsite marks the southern limit of Wisconsian deposits. Glacial deposits on the right bank are Wisconsian and on the left bank are Illinoian. Caesar Creek is embedded in bedrock at the damsite with a valley width of about 300 feet. Bedrock in the valley is about elevation 724 and bedrock extends above spillway crest elevation 883 in both abutments. Bedrock is the Richmond Formation of interbedded limestone and shale, Ordovician in age. Approximately 2.5 miles above the dam, Caesar Creek flows in a broad meandering valley of glacial deposits. Maximum relief is 300 feet. A dendritic drainage pattern has developed. Prior to the Illinoian glaciation, the drainage pattern was quite different than that of today. A southward flowing river, referred to as the "Hamilton River" cut a deep bedrock channel through Green, Warren and Clinton Counties. This preglacial river split between New Burlington and Harveysburg. The west arm of the river flowed in the present Little Miami River valley and the east arm flowed in a southeast direction until it reached the present Todd Fork Valley where it turned southwest following the present Todd Fork Valley. Both arms of the river are now buried valleys. The west area of the valley is not in the reservoir whereas the east arm does cross the reservoir about 5 miles upstream from the dam. Approximate top of bedrock in the buried valley is elevation 750. The drainage divide between Caesar Creek and the Little Miami River is located in the old Hamilton River bedrock channel. The drainage divide is a Wisconsian end moraine that was deposited as hills and ridges at the edges of the glacier. The ridges are not truly connected, but rather irregularly grouped together into more or less well defined belts. The drainage divide is composed of clay till with interbedded sand and gravel. The end moraine deposits lack the compactness characteristics of ground moraines which have been over-ridden by the heavy ice sheets. Formation at the damsite is a calcareous shale with 10-15 percent interbedded limestone which has 0.1 foot to 1.0 foot thick beds. The dominant joint pattern is N60W and N40E. The site is considered quiescent and no earthquake shocks

are known to have occurred which have caused an intensity greater than II on the Modified Mercalli Scale. The nearest and greatest disturbance of record was reported in the Cincinnati area on 17 October 1937.

b. Damsite. The topography along Caesar Creek in the damsite area is characterized by a broad, flat upland which has a steep-sided rock cut gorge running throughout. Rock outcrops in the tributary streams immediately upstream and downstream from the dam centerline. The drainage pattern is dendritic. Tributary streams are fed from springs high on the drainage divide and flow along gentle gradients in the glacial till and finally along bedrock near the mouth. Residual lean to fat clay is found on both abutment side slopes and in the spillway area. On the left abutment it is 2 to 5 feet thick whereas on the right abutment side slopes it is as thick as 10 feet. The clay is moderately firm with limestone fragments scattered throughout. In the spillway area the clay is 2 to 12 feet thick. Along the toe of the right abutment is 16 to 26 feet of colluvium. The colluvium varies from a fat clay to a gravelly clay. Colluvium is also found on top of the drainage divide in both abutments. Wisconsian till is found on the right bank and Illinoian till is found on the left. On the right abutment the till thickness varies from 10 to 30 feet. The top 10 to 15 feet is a brown leached clay till which overlies 10 feet of gray clay till. The lower 3 to 8 feet is a gray brown clay till, Illinoian in age. On the left abutment the maximum thickness of overburden is found, just at the top of the hill where a topographic high is evident. The till has a maximum thickness of 28 feet and thins out toward the spillway where overburden is 2 to 7 feet thick and is primarily a residual lean clay with rock fragments. Alluvial sandy clay and gravel is found in the narrow valley bottom. Immediately overlying bedrock is a sandy gravel with some silt, clay and organic clay. The gravel has a maximum thickness of 20 feet at the downstream left bank toe. Overlying the gravel is some 10 to 15 feet of sandy silty clay which is soft to moderate soft. The geologic profiles and sections for the dam are shown on plates 4 through 10. For reference, a boring location plan is presented on plate 3.

3. Foundation and Abutment Treatment. The general abutment stripping varied from 1 to 3 feet in depth to residual soil. Stripping in the valley to much greater depths was necessary to remove wet and weak materials that contained organic materials in and adjacent to the streambed. The valley was excavated to sand and gravel or bedrock. The greatest depths of excavation were along the left side of the valley and at the downstream central portion where brown silty clays and scattered pockets of peat were removed to bedrock at elevation 726. The elevations of the stripped valley foundations are shown on Plates 13 and 14.

The cutoff was excavated 5 feet into rock (shale and limestone) with a bottom width of 50 feet below elevation 760 which extended between stations 19+50 and 23+50. The cutoff width was transitioned to 20 feet wide at the ends of the trench, stations 15+20 and 27+50.

The side slopes were 1H on 1V in rock and 1.5H on 1V in sand and gravel or residual soil. The foundation in the valley bottom cutoff trench was founded on a layer of limestone except for the quarter near the left abutment. At that location, the limestone layer had been broken through and the shale beneath it required more careful cleaning. Problems of cleaning the shale were also compounded by seepage from the left abutment through the overburden and also through the surrounding sands and gravels. Two sumps were dug at the downstream edge of the trench. One at the toe of the left abutment was cut 4 feet into rock and sandbagged. The other, 20 feet up station, acted as a drain for the sand and gravel. The upstream edge of the trench was benched at the interface between sand and gravel and sloped toward the sump located at the axis of the dam. These sumps were filled with 2 feet of impervious fill and hand-tamped with power tampers. The cutoff on the valley sides presented no difficulties except for seepage through the sand and gravel from approximately stations 25+40 to 27+00 which was controlled by the construction of the gravel packed sump at station 26+96. A 6-foot deep inspection trench was excavated from the ends of the cutoff trench (stations 15+20 and 27+50) to the ends of the dam embankment (stations 2+51 and 30+00). The trench side slopes were 1.5H to 1V and had a 6-foot wide bottom. Where sandy deposits

occurred at the bottom of the trench, it was excavated to the bottom of the sand. A 3-foot over excavation was made at station 28+00. No serious leakage problems were anticipated in the foundation under the dam fill, so a minor grouting program was undertaken. A single line grout curtain along the dam axis was placed to a depth of 30 feet below the top of rock, excepting the upper portion of the left abutment. From stations 15+20 to 16+67, the grout curtain was extended to elevation 812. The contract called for split spacing, stage grouting method with the primary grout holes on 20-foot centers. All holes were angled 20 degrees into the slope to intercept the maximum number of vertical fractures. All holes were drilled in this manner, but only 2 holes required more than 1 stage. During the grouting, several holes developed surface leaks 5 to 10 feet down the slope from the hole being grouted. The leakage occurred along shale-limestone contacts which were probably disrupted during excavation. When excessive leakage occurred, a 10-foot packer was used to grout the lower portion of the hole. The packer was then removed and the grout was thickened to stop the leaks in the upper portion of the hole. Grout take was minimal with most of the grout being used to stop surface leaks. Only four secondary holes were drilled to insure adequate grouting in cases where lower portion grouting of the primary holes were questionable.

Rock surfaces were exposed prior to embankment placement throughout the cutoff trench, on either side of the outlet works and in certain areas of the valley. Vertical faces in rock existed in the abutment areas at the termination of limestone seams. These faces were 1 foot or less in thickness and required no special excavation technique prior to placement of embankment material. When an overhang was produced by excavation operations, the overhang was removed by hand methods. The steepest slope face to receive embankment was 4V to 1H as excavated along the right abutment for outlet works construction. Cracks or fissures within the cutoff trench and foundation area were not found with openings large enough to be filled with grout. Loose rock and coating was removed from the rock surface by use of picks, shovels and brooms ahead of embankment placement.

4. Embankment.

a. General. The embankment section consists of compacted random fill and a compacted impervious core. The random fill zones are rock except the upper portion of the downstream zone which is clay. The embankment is 2,748 feet long with an upstream slope of 3.5H on 1V and downstream slope of 3H on 1V. The top of dam is elevation 903 with a cres width of 42 feet to provide for a county road. The core has symmetrical side slopes of 1H on 4V. Internal drainage is controlled by a 5-foot wide sloping filter drain on the downstream side of the core from elevation 883 down to where it ties into either a 3-foot thick horizontal filter blanket on the stripped foundation or extends 5 feet into the sand and gravel left in place in the valley bottom. A 5-foot wide transition zone was placed between the inclined drain and the downstream random fill zone from the horizontal drain up to the top of the random rock zone. The upstream face of the dam is blanketed with a 20-inch thickness of 150 pound maximum size stone on a 9-inch layer of bedding from the top of the dam to elevation 795. The downstream slope of the dam was covered with a 12-inch layer of topsoil from the spillway stripping. The site plan and typical dam sections are shown on plates 11 and 12.

b. Materials Sources. Approximately 2,296,000 cubic yards of earth and random fill, drainage and transition material, and protection stone was required in the dam section. The material used to construct the primary embankment zones was first obtained from required excavation and then from designated borrow areas. The granular borrow area is shown on Plate 16. Materials for the impervious core came from spillway overburden, borrow area 2 and the outlet works excavation. (See Plate 15.) A small portion of the impervious material came from the cutoff trench excavation. Random rock was obtained from the spillway excavation, borrow area 1 and the cutoff trench excavation. The random earth zone material was obtained from stockpiles of dam foundation excavation, the valley portion of the cutoff trench and the inlet and outlet channel excavation. All materials excavated were used in the embankment except surplus topsoil that was stockpiled left of the spillway and upstream of the left

abutment access road, the material from the foundation excavation, unsuitable for embankment, that was wasted and material used in haul roads. The Materials Usage Chart is shown on Plate 17.

c. Compaction Equipment. The following rollers were used in compacting the embankment materials:

Sheepsfoot Rollers:

a. Ferguson Model 120F

b. Self-propelled

c. 2 drums, side-by-side, 5.5' long x 5.5'diameter.

d. 3,040 lb/ft empty

e. Oscillating frame and spring cleaner

f. Specified 5 mph maximum speed

g. 1,073 psi foot pressure-ballasted

Vibratory Rollers:

a. Rago Rascal Model 400A

b. Self-propelled

c. 1 drum, 4.92' diameter

d. Static weight 23,500 pounds

e. Frequency of vibration 1100-1500 vibrations per minute

f. Specified 3.5 mph maximum speed

g. Dynamic force 27,000 pounds

Pneumatic-Tired Rollers:

a. Tampo Model 50

b. 4 tires, 24 ply. 18.00x25, 8 in apart

c. Specified 5 mph maximum speed

d. Roller width 9'4" overall

e. Weight 19,000 pounds empty

f. Weight 100,000 pounds w/85 psi

g. Contact pressure 75 psi loose material

150 psi compacted material

d. Earth Placement. Impervious fill was placed in the impervious zone, cutoff and inspection trenches and adjacent to the sides of the operating tower. Material was spread in layers of not more than 6 inch thickness before compaction. Each layer was disked until clods were broken down and desired moisture content was obtained. Moisture content after compaction was required to be within the limits of 1 percentage point above optimum and 1 percentage point below optimum as determined in the field. In-place moistures of excavated material averaged 3 to 4 percentage points above optimum, making drying necessary both at the source and on the embankment. The layers were compacted by six passes of a sheepsfoot roller. Additional rolling was not necessary to attain the desired compaction.

In the compaction of the impervious and random earth embankment materials, the design requirements for density were considered met if the field density tests indicated densities of the compacted materials were 95 percent or greater of the maximum densities as determined from EM 1110-2-1906 Appendix VI (Standard Compaction Test). A nest of moisture-density curves covering the range of soil used was developed. (See plates 24 through 26.) Soils with 100 percent passing the No. 4 sieve were

compacted in a 4-inch mold. Soils with fractions retained on the No. 4 sieve and passing the 3/4-inch sieve were compacted in a 6-inch mold. A 1 point standard compaction test at 1 to 2 percentage points below optimum was made from each in-place density test material for identifying the applicable maximum density and optimum moisture from the nest of curves. Tests were performed by Contractor quality control technicians in a field laboratory at the Resident Office under the supervision of a Government technician who also performed check tests for comparison with the Contractor tests. The total number of tests performed were as follows.

| | Dam | Dike |
|---|---|---|
| Total Contractor Tests | 247 | 597 |
| Total Government Tests | 102 | 52 |

The distribution of density tests performed on the impervious material, the random material and the drain material are shown on plates 18 through 21. A summary of field compaction control test data and design placement requirements for the dam is shown on plate 22. A summary of field compaction control test data and design placement requirements for the dike is shown on plate 23.

e. Rock Placement. Random rock from required excavations and borrow area No. 1 was placed upstream of the impervious core zone from the foundation to the top of the dam and downstream of the impervious core from the foundation to elevation 860. The material was dumped and spread in layers not more than 8 inches thick before compaction. Each layer was compacted by 4 passes of a sheepsfoot roller and 2 passes of a 50-ton pneumatic tired roller.

Density tests were performed by using a template placed on the compacted rock. A hole approximately 2'x2'x2' was carefully excavated by using a pick, shovel, and small hand tools. The weight of excavated material was obtained. The hole was lined with plastic and filled with water to the

calibration mark. The water used to fill the excavation to the calibration mark determined the volume of material excavated, thus weight per cubic foot was obtained.

Listed below are locations and results of the random rock tests:

Table 1

| Test No. | Station | Offset | Elevation | Density ($\#/Ft^3$) |
|---|---|---|---|---|
| 1 | 22+00 | 450 FT US | 749 | 141.2 |
| 2 | 21+00 | 147 FT US | 736 | 145.4 |
| 3 | 20+00 | 450 FT US | 772 | 151.4 |
| 4 | 20+70 | 265 FT DS | 810 | 123.3 |
| 5 | 20+80 | 18[illegible] FT DS | 845 | 131.0 |
| 6 | 17+80 | 48 FT DS | 890 | 139.9 |

A percolation test was also performed in the excavated holes. The results of these tests showed that the absorption rate of the random rock varied substantially, from .0006 ft/min to .0433 ft/min.

f. Seepage Control. The seepage control consisted of a five foot wide vertical drain inclined four vertical to one horizontal and a three foot wide blanket of filter sand on both abutments extending horizontally from the incline drain to within five feet of the outer slope and vertically to elevation 883. The drain is constructed between the downstream rock zone and the impervious core.

There is also a 5-foot wide transition zone between the filter and random rock zone. The following is a specified grading of the two materials:

| Filter Sand | | Transition Stone | |
|---|---|---|---|
| Sieve | Percent Passing | Sieve | Percent Passing |
| 3/8" | 100 | 2" | 100 |
| No. 4 | 95-100 | 1-1/2" | 95-100 |

| | | | |
|---|---|---|---|
| No. 16 | 45-80 | 3/4" | 35-70 |
| No. 50 | 10-30 | 3/8" | 10-30 |
| No. 100 | 0-5 | No. 4 | 0-5 |

To assure a good interface between filter and clay, clay was overlapped on the top of the filter and then cut back to provide a smooth compacted vertical face. With adequate water and uniform grading of material, desired compaction was generally achieved with 4 passes of the roller.

A toe drainage system was constructed across the valley and discharges into the stilling basin. The drain extended down into the pervious foundation. The toe drainage system is shown on plate 27.

g. Shear Strengths. Because of the low shear strength and organic content of the alluvial foundation of the dam, it was determined that these materials would be removed. The alluvial foundation materials in the dam were stripped. The residual material on the upper portion of the abutments was left in place. The adopted Q strengths were obtained from a plot of cohesive strength versus moisture content and were adopted from test results to represent materials 2 percent wet of optimum. The R and S strength values for the impervious fill were adopted from a composite of test value envelopes. The shear strengths for the rolled random rock were based on shear tests for weathered materials from the spillway.
The Adopted Shear Test values are presented below.

Table 2

Adopted Soil Design Values

| Embankment Materials | $\gamma_d$ PCF | $\gamma_m$ PCF | $\gamma_s$ PCF | $\gamma_b$ PCF | Shear Values Type Test | Tan Ø | C TSF |
|---|---|---|---|---|---|---|---|
| Impervious (Lt. Abutment Borrow) | 105.6 | 132.5 | 134.6 | 72.2 | Q | 0.071 | 1.13 |
| | | | | | R | 0.287 | 0.19 |
| | | | | | S | 0.454 | 0.00 |
| Impervious (Rt. Abutment Borrow) | 105.6 | 127.0 | 129.0 | 66.6 | Q | 0.130 | 1.00 |
| | | | | | R | 0.375 | 0.30 |
| | | | | | S | 0.547 | 0.00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Random Fill (Rock) | 109.0 | 135.0 | 14[illegible] | 77.6 | Q | 0.368 | 1.[illegible]5 |
| | | | | | R | 0.330 | 0.50 |
| | | | | | S | 0.650 | 0.00 |

The random rock materials were obtained from the weathered portion of the spillway. It was felt that they did not represent the bulk of the materials that were to be used in the fill. Therefore, during construction, unweathered materials were obtained and sent to South Atlantic Division laboratory for testing. Cube samples were also taken from the embankment core and tested by Ohio River Division laboratory. Below are the results of the additional testing.

Table 3

Testing After Feature Design Memorandum

| Materials | $\gamma_d$ PCF | $\gamma_m$ PCF | Type Test | Shear Values: Tan Ø | Shear Values: C TSF |
|---|---|---|---|---|---|
| Impervious (Lt. Abutment Borrow) | 108.6 | 128.3 | Q | 0.000 | 1.25 |
| | | | R | 0.296 | 0.20 |
| | | | S | 0.520 | 0.00 |
| Random Fill (Rock) | 109.0 | 135.0 | Q | 0.727 | 1.40 |
| | | | R | 0.325 | 0.25 |
| | | | $\bar{R}$ | 0.767 | 0.30 |

h. Stability Analyses. The dam embankment sections were subject to analyses by the circular arc and sliding block and wedge methods. Slope stability computations for the circular arc analysis were made with an IBM 360 computer using Program No. 41-K2-H2-03. Slope stability computations for the block and wedge analysis were made with an IBM 360 computer using Program No. 41-K2-H2-02. The stability of the critical condition was checked by manual computations. The methods used in determining the factor of safety follows the procedures outlined in EM 1110-2-1902. The slopes were analyzed for the end of construction, sudden drawdown, partial pool and steady seepage cases. The circle analysis proved critical in every case. Since the damsite is not in an area of seismic activity, no earthquake analysis was considered. Cases studied along with values obtained are presented below in Table 4.

Table 4

| Case Studied | Minimum Safety Factor Circular Arc | Block & Wedge | Required |
|---|---|---|---|
| **Dam** | | | |
| End of Construction Upstream | 2.37 | -- | 1.3 |
| End of Construction Downstream | 2.23 | 2.34 | 1.3 |
| Sudden Drawdown | 1.20 | 1.29 | 1.2 |
| Partial Pool | 1.53 | -- | 1.5 |
| Steady Seepage | 1.77 | 1.69 | 1.5 |

End of Construction.

Q shear strengths are applicable for this case. A minimum factor of safety of 2.37 was obtained for the upstream section. A minimum factor of safety of 2.23 was obtained for the downstream section.

Sudden Drawdown.

R shear strengths are applicable for this case. The upstream slope was analyzed for drawdown from spillway crest to a minimum pool for a maximum drawdown of 83 feet. Full uplift was assumed with saturated weights utilized below the saturation line. A minimum factor of safety of 1.20 was obtained.

Partial Pool.

R shear strengths are applicable for this case. The pool elevations considered were spillway crest elevation, minimum pool elevation and no pool. Full uplift was utilized with horizontal saturation lines. A minimum factor of safety of 1.53 was obtained.

Steady Seepage.

R and S strengths are applicable for this case. The internal drainage system was considered operative. The embankment was considered to be

saturated to spillway crest upstream of the inclined drain. No tailwater was considered. A minimum average factor of safety of 1.[illegible] was obtained.

The stability analyses are shown on plates 28 through 32.

## 5. Diversion and Closure.

a. Diversion. The dam diversion plan is presented on plate 33. Diversion of the stream occurred on 14 July 1973 and stripping across the entire valley started on 19 July 1973. Diversion was accomplished by temporary cofferdams immediately upstream and downstream of the respective toes of slope. The centerline of cofferdam "B" was 7[illegible] feet upstream of centerline of dam. The cofferdams were taken to rock except for a small section of "B" which was founded on sand and gravel with a 4-foot wide trench to rock. The cofferdams had side slopes of 2H on 1V with a 10-foot top width at elevation 745 and were composed of material from cofferdam "A" (around outlet works) which was outlet works excavation.

One week after diversion, the runoff from a severe storm caused overtopping of the diversion cofferdam. The cofferdams were overtopped again on 24 July 1973, a fews hours after being restored. On the same day, a restraining order was issued in Federal Court which stopped all project work. Several times during construction the outlet channel became partially blocked by outwash from a small stream which empties into the channel from the right bank. The streambed has a gradient of 7.5 percent which produces a high velocity flow that carries limestone fragments to the outlet channel during heavy runoff. Although one gabion structure was built just above the outlet channel, the outwash problem may reoccur during future heavy stream flows.

b. Stage I, Permanent Cofferdam. The foundation of Stage I was excavated and the embankment placed from 19 July 1973 to 2 November 1973 with the major embankment effort occurring between 11 October and 2 November 1973. Three wells were sunk just upstream of the upstream toe on 40-foot centers and three wells were just upstream of the centerline of

the dam to control seepage. The wells were screened with 24-inch diamond slotted pipe and pumped with 3-inch electric pumps. Results were generally poor to fair, depending on the amount of effort put forth by the Contractor to develop this system. Part of Stage I had been placed earlier (before diverison) on the left side of the tower to facilitate the sequence of operations after diversion.

Stage I was built to elevation 805 with an upstream slope of 3.5H on 1V and a downstream slope of 2H on 1V with a 20-foot top width. A cutoff trench was excavated to rock through sand and gravel with a centerline 90 feet downstream from the upstream toe with 2H to 1V side slopes and a 10-foot bottom width. The embankment material was compacted random rock mainly from the spillway. Stage I and subsequently Stage II are the upstream portions of the permanent fill and were intially constructed to protect the rest of the foundation from flooding and allow it to be excavated in the dry.

c. Stage II, Permanent Cofferdam. Stage II was completed 14 November 1973. This extended the embankment to 820.0 with 3.5H to 1V upstream slope and 2H to 1V downstream slope with a 5 -foot top width. Compacted random rockfill from the spillway was used.

6. Construction Notes. The prime Contractor was Butt and Head, Inc., 3858 New Germany Road, Dayton, Ohio 45431. The contract, DACW27-72-C-0086, Construction of Outlet Works, Dam, and Spillway, Caesar Creek Lake, was awarded on 1 March 1972 and involved construction of the earth and rockfill dam, the excavation and construction of the gate controlled outlet works at the base of the right abutment and the uncontrolled spillway on the left abutment, excavations of the inlet and outlet channels of the outlet works, and construction of the service bridge, access roads, parking areas and trash boom. It also included clearing and grubbing, site grading, placing of stone protection and seeding. Following grubbing of the construction site, excavation was performed for the outlet works along the toe of the

right abutment. Concrete placement started in August 1972 on the stilling basin and continued on the outlet works through the following winter. The stilling basin and conduit concrete were completed during the spring of 1973. The outlet works conduit was constructed in an open cut of reinforced concrete in 20-foot monoliths with the exception of monoliths 1 and 44 which are 15' long. Lean concrete fill was used under the entire length of the conduit in order to found on firm rock. The lean concrete also had two other purposes: (1) to provide a working pad for placing formwork for the conduit proper, and (2) to protect the rock surface from deteriorating until the invert was placed. In the impervious zone of the dam, lean concrete fill was placed to the top of the conduit on the landward side, over the full width of the excavation and three seep rings were placed around the conduit. Beyond the impervious zone on the landward side, granular fill was used to top of conduit over the full width of excavation. In order to insure that the backfill will maintain contact with the vertical sides of the conduit, the sides were given a batter of 1 horizontal to 10 vertical. Cut slopes are 4 on 1 in rock and 1 on 1.5 in earth. The surface between the lean concrete cradle and the conduit was given a coat of bituminous paint to break the bond. The inlet and outlet diversion channels were excavated in June and July 1973 and the stream diverted through the conduit on 14 July 1973. At that time, the tower concrete was placed to elevation 787, the service and emergency gates, frames, liners, bonnets and cylinders were in place and the left abutment cutoff trench was excavated and grouted. On 19 July 1973, the Attorney General of Ohio filed a complaint in the Federal District Court: State of OHio, Ex rel William J. Brown, Attorney General of Ohio vs. Howard H. Calloway, Secretary of the Army, et al, Civil Action Nos. 8892 and 8893. It contended that the construction work at Caesar Creek Lake should be halted until the United States complied with certain laws. There were several allegations of noncompliance by the Attorney General, but his main contention related to noncompliance with the National Environmental Policy Act in that, he alleged, the environmental impact statements were inadequate and did not satisfy the requirements of Section 102 of NEPA. As a result of this litigation, all significant work at the project was stopped by the Court's Order of 24 July 1973 pending the filing of a

complete and adequate Environmental Impact Statement. The restraining order was partially lifted on 11 September 1973, allowing work to continue on the permanent cofferdam and operating tower. On 11 October 1973, the major embankment effort started on the permanent cofferdam. Stages I and II of the cofferdam were completed on 2 November 1973 and 14 November 1973, respectively. The valley portion of the cutoff trench was excavated and grouted later, then all work was discontinued until the court injunction was vacated and suspension claims were settled. The court injunction was vacated in June 1974. However, because of the unavailability of construction equipment in the late spring and early summer of 1974 and due to the indefinite nature of the court-imposed suspension, the prime Contractor decided to subcontract the earthwork to a firm with the necessary personnel and equipment. The low bid and work went to the Geupel Construction Company, Inc., of 1661 W. Henderson Road, Columbus, Ohio 45220. Remobilizing began in August 1974 for construction of the dam and other site work. Geupel placed the dam embankment to elevation 737 by November 1974 when the weather prevented further work. The embankment work was resumed again the first week in April 1975 and the dam was topped out in August 1975. The roads, spillway control structure and other site work were substantially completed in November 1975, but the prime Contractor did not complete the control tower until June 1976 at which time the final inspection was held. After a revised Impact Statement was compiled, an agreement was reached with the Ohio Attorney General's Office in early 1975 and further court action was not expected. Contract supervision was provided by the Government in the form of a resident office, administered by a resident engineer acting as a representative of the District Engineer. Personnel requirements for supervision of inspection of the work varied from time-to-time. The inspection force was sufficient to maintain effective control of the work during construction.

7. Modifications. There were 37 modifications for the construction of the Outlet Works, Dam and Spillway. Significant modifications are listed below:

Modification 3 deleted instrumentation around the conduit in three locations which were to have been installed by the Government.

Modification 7 gave the Contractor the option to use offsite granular material for placement behind the conduit, under riprap at the stilling basin wingwalls and in back of the stilling basin wingwalls. The original contract only specified selected streambed sand and gravel material excavated from the cutoff trenches for the cofferdams and dam to be used as a granular backfill.

Modification 13 provided construction of a 3-foot wide minimum collar of impervious fill material around the tower to meet plan impervious plugs for seepage control.

Modification 15 provided settlement for suspension of the contract and includes settlement of several outstanding cases which existed before and during suspension. Two of the cases affected the embankment and/or abutment design. Case 8 deleted a portion of the cribwall on the downstream right abutment and represented a 75 percent reduction in the original plan quantity. The rock slopes where the cribwall was to have been built, were excavated steeper than original contract plans as a result of Case 8 and seeded with crown vetch. The reasons for deletion of the cribwall were principally due to concern over the potential for deterioration and erosion of the exposed shale below the bench on which the wall would be built. Case 103 was for change of datum elevations from 1912 to 1929 to be consistent with the datum used throughout the rest of the lake project area. Order to change to 1929 datum was given to the Contractor on 22 June 1972. The adjustment was accomplished by adding 1.10 to the benchmark elevations on the plans.

Modification 20 allowed the Contractor to place random rock embankment to elevation 842.0 in the portion of the dam upstream of the impervious core in advance of the impervious fill. The upstream slope was built 3.5H to 1V to match the previously constructed Stage II cofferdam. The top was an average of 35 feet wide. The downstream slope was built 2H to 1V with a 28-foot wide haul road built on the face of the slope starting at the top on the right abutment and ending at the toe of the left abutment. This

allowed random rock placement during the early spring of 1975 while clay for impervious fill was too wet to work.

Modification 25 allowed use of borrow area No. 2 clay for impervious fill. Actual quantity used was 34,340 cubic yards.

Modification 36 added a 3-inch and a 4-inch PVC conduit underground across the upstream top of the dam for future electric and telephone cables.

Other changes which were not contract modifications include:

Initial stripping of the abutment was generally 1 foot instead of 4 feet as required as residual soil was found at the shallower depth. During the 1975 construction season, silty, sandy material was encountered in the upper portion of the right abutment, downstream from the cutoff trench and this material was removed with the greatest depth of 12 feet at Station 25+50. Natural granular material did not extend along the base of the abutments; therefore, unsuitable material was excavated down to rock along each side of the streambed granular material. The excavated material was replaced with random rock for leveling and topped with the horizontal dam filter. This resulted in overruns beyond the plan estimated quantities for dam foundation excavation and for the horizontal dam filter. All other modifications and changes applied to features of the contract other than the embankment.

8. Initial Filling.

a. General. Operations personnel at the damsite reported daily to the Regulation Section in Hydrology and Hydraulics Branch. Routine data reported consisted of pool elevation, damsite and observer rainfall, and pertinent stream stages. When rainfall conditions merited, collection of intermediate data from the damsite and from the NWS observer rain gages at Xenia, Wilmington, and Sedalia provided additional information needed to determine the most advantageous operating procedure. Regulation Section developed a reservoir inflow model for the area contributing to Caesar

Creek Lake; results from daily application to the model served as a basis for estimating project inflows. Based on these forecasted conditions, the Regulation Section disseminated operating instructions to assure maintenance of the desired filling schedule.

b. Filling Schedule. The filling of Caesar Creek Lake was done in three steps with a pool holding level of 5 days in between steps so that instrument reading and other observations could stabilize. The proposed and actual filling curves are shown on Plate 34.

The filling schedule, showing filling rates, rate of rise, and inspection or stabilization periods, is shown as Table 5.

Filling rates below elevation 800 were in excess of 1 foot/day however, since during construction the pool had been as high as elevation 800 and since elevation 780 had been exceeded several times during construction with no apparent problems, pool increases in excess of 1 foot/day in the lower lake levels were acceptable.

Table 5

Proposed Filling Schedule

| Date (1978) | Average Filling Rate | Elevation | Capacity (Day-Second-Feet) | No. of Days | Average Rate of Rise |
|---|---|---|---|---|---|
| 03 Jan | | 736 | 0 | | |
| | 231 cfs | | | 29 | 2.2 ft/day |
| 31 Jan | | 800 | 6,703 | | |
| | -- | | | 5 | -- |
| 05 Feb | | 800 | 6,703 | | |
| | 645 cfs | | | 25 | 1.0 ft/day |
| 02 Mar | | 825 | 22,823 | | |
| | -- | | | 5 | -- |
| 07 Mar | | 825 | 22,823 | | |
| | 530 cfs | | | 54 | 0.44 ft/day |
| 01 May | | 849 | 51,441 | | |

Flow in excess of the desired filling rate passed through the conduit.

If at any time during the winter project inflows were higher than the release capability, the gates reamined fully open until the pool

stabilized. As inflows receded, the release was reduced commensurately in an effort to maintain the pool. After sufficient period for project inspection and instrument stabilization and after Geotechnical Branch had deemed conditions acceptable, filling continued at the prescribed rate.

During periods when the pool level was below the scheduled elevation and inflows were in excess of the prescribed filling rate, additional water was stored provided the rate of change of pool level did not exceed 1.0 foot/day.

c. Monitoring Procedures.

(1) General. During the initial filling of the reservoir, the dam and abutments were monitored for seepage by piezometers and surveillance of the downstream dam face and abutments. During the entire period the manholes of the toe drain of the dam were monitored as observation wells. Horizontal and vertical movements of the dam embankment were monitored by movement markers.

(2) Location of Instruments. Casagrande type piezometers are installed along stations 22+00 and 26+55 of the dam. Wellpoint piezometers are placed along the downstream toe of the dam embankment and on the right abutment. A single line of movement markers is located along the downstream crest of the dam. Three manholes associated with the toe drainage system are installed approximately 520 feet downstream.

(3) Observation Frequency. Piezometers and manholes were read daily until the all-season pool elevation 849 was reached and readings stabilized. Stabilization readings were taken on a weekly basis for the first year and on a monthly basis thereafter except during a rise in pool. Movement monuments were read monthly during the initial filling and quarterly thereafter. Surveillance of the dam and abutments was on a 24-hour basis during the initial filling.

(4) Reporting and Evaluation of Data. An engineer from the Geotechnical Branch was located at the project site during filling. The engineer kept data plots current, evaluated the results, and kept the District Office informed per daily telephone reports.

d. <u>Emergency Plan</u>. An emergency plan is being developed for all lakes in the Louisville District that will provide for orderly notification and evacuation of downstream residents in case of possible dam failure. Such plans will include, but not be limited to, inundation maps, points of contact, notification procedures, lake drawdown, and other pertinent items.

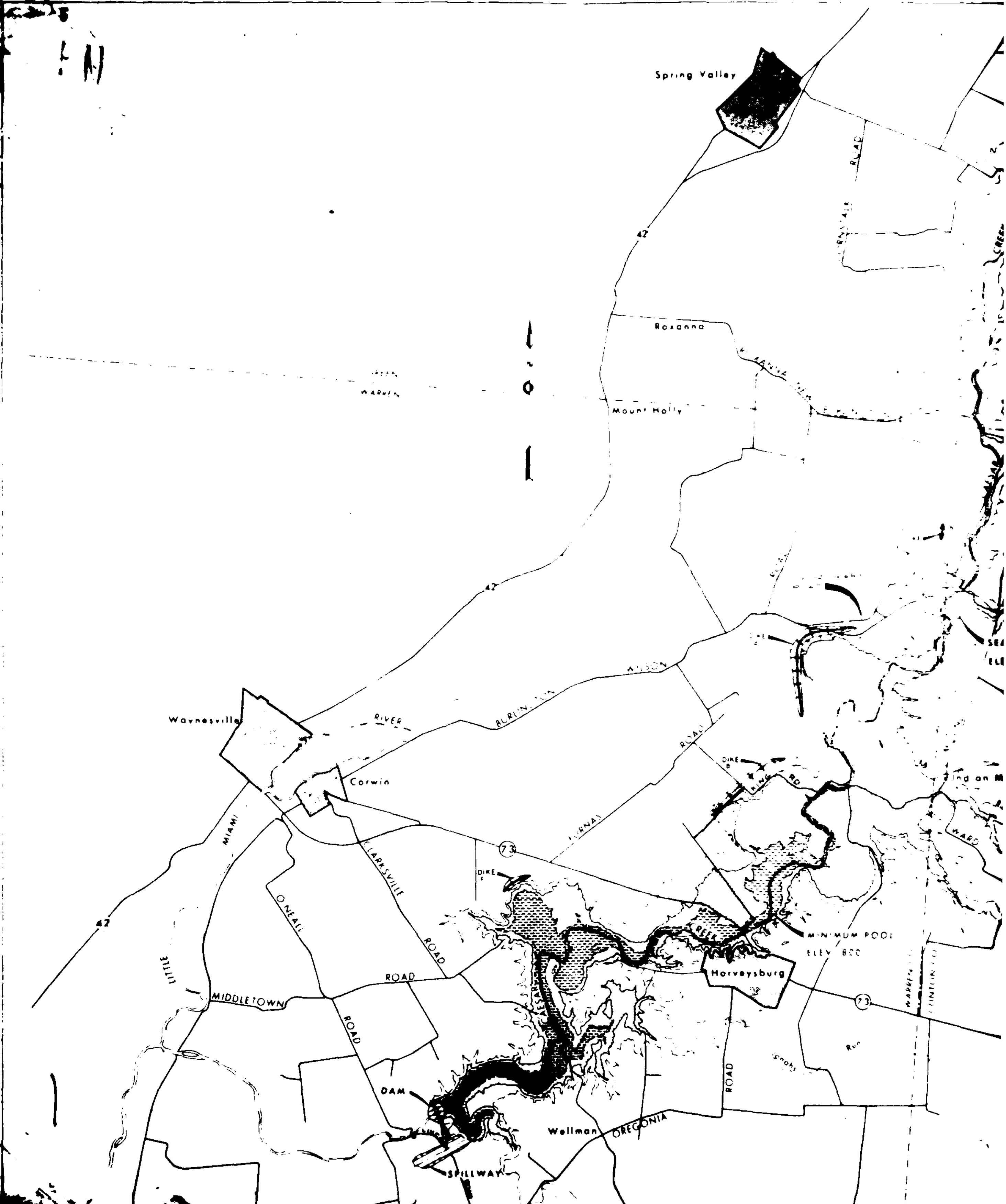
9. <u>Instrumentation</u>.

a. <u>General</u>. The instrumentation consists of piezometers, observation wells and movement monuments. The main dam has 10 piezometers in the embankment, 8 observation wells on the abutments, and a single line of movement monuments. Instrumentation plans, details and sections are shown on plates 35, 36 and 37.

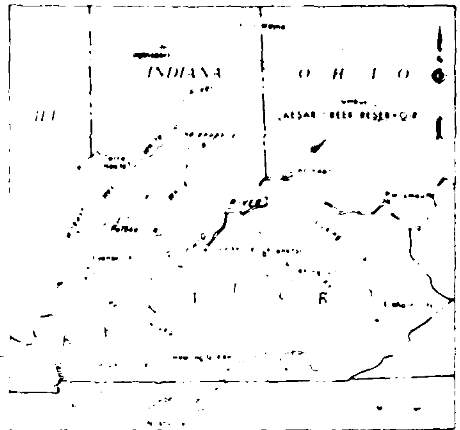
b. <u>Piezometers</u>. Piezometers 6, 7 and 8 on the upstream side of the core reflect the pool indicating that the random rock zone is becoming saturated. The other upstream piezometer, number 9, is dry since its tip is at 846 which is above the present pool. Piezometers 3 and 4 on the downstream side of the core are both dry and along with piezometers 1 and 5 with low readings indicate that the core is effectively reducing the head. Piezometer 10 on the downstream side of the core is apparently influenced by ground water. The piezometer plots are shown on pla[illegible] through 41.

c. <u>Observation Wells</u>. Observation wells 11, 12, 13 and 14 on the right abutment are also apparently influenced by ground water. Observation wells 15 and 16 on the downstream side of the core fluctuate just above the tailwater. Observation wells 18 and 19 on the left downstream abutment react to the pool indicating slight seepage coming through the left abutment.

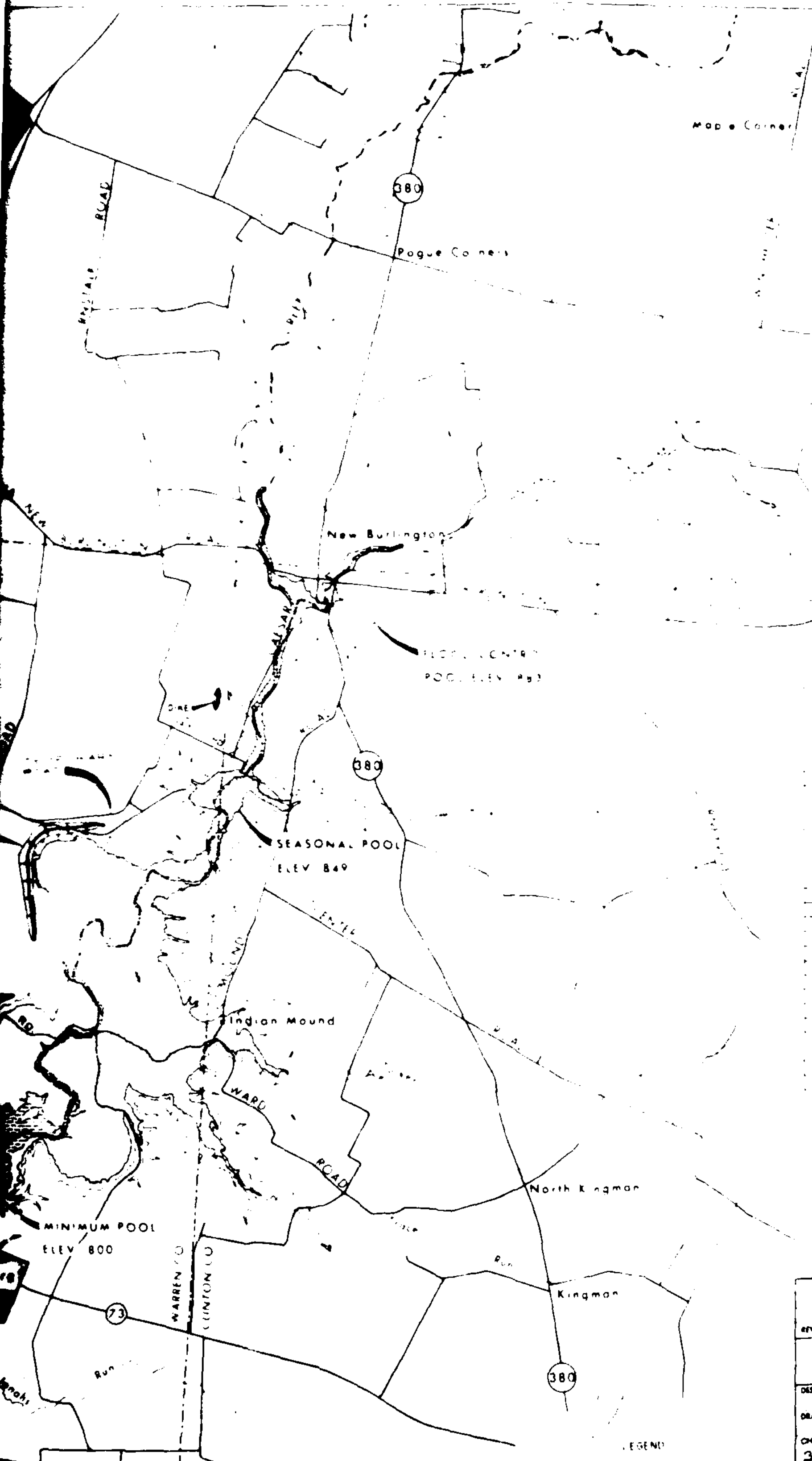
d. Movement Markers. The maximum vertical settlement of [illegible] foot occurred at the maximum embankment section. The maximum horizontal movement of 0.18 foot occurred at the maximum embankment section. The horizontal and vertical movement plots are shown on plates 4[illegible] and 1[illegible].


Spring Valley
42
Roxanna
Mount Holly
Waynesville
RIVER
Corwin
MIAMI
42
CLARKSVILLE
O'NEALL
ROAD
LITTLE
MIDDLETOWN
ROAD
ROAD
DAM
SPILLWAY
Wellman
OREGONIA
ROAD
73
DIKE
FURNAS
ROAD
Harveysburg
MINIMUM POOL
ELEV 600
73
WARD

U S ARMY




VICINITY MAP




INDEX

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| | DIKE A PLAN & PROFILE SHEET 2 |
| 4 | DIKE A CROSS SECTIONS |
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| 25,25A | DIKE A BORING LOGS |
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| 32 | SOIL CLASSIFICATION CHART & LEGENDS |
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SIGNATURES APPEARING IN THE TITLE OF THIS SHEET CONSTITUTE APPROVAL OF ALL DRAWINGS LISTED IN THE INDEX TO DRAWINGS SHOWN ON THIS SHEET

ALL DRAWINGS IN THIS FOLIO HAVE BEEN REDUCED TO ONE HALF THE ORIGINAL SCALE

LEGEND

FLOOD CONTROL POOL ELEV 883

SEASONAL POOL ELEV 849

MINIMUM POOL ELEV 800

SCALE IN FEET

1000 0 2000 4000

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U S ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
CAESAR CREEK RESERVOIR
LITTLE MIAMI RIVER
DIKES
RESERVOIR AREA MAP

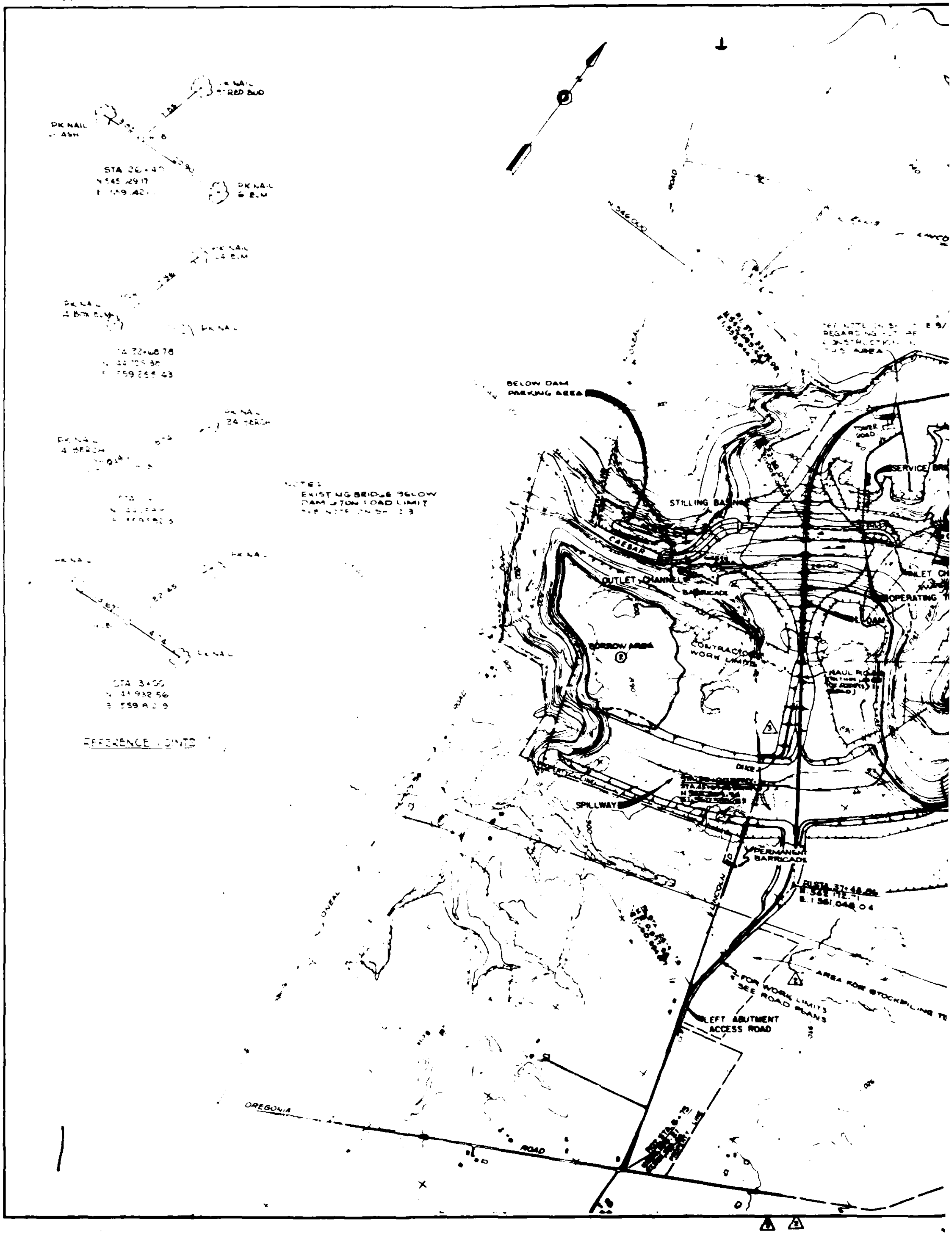
DESIGNED · DRAWN · TRACED · CHECKED · SUBMITTED · APPROVAL RECM · APPROVED · APPROVED · SCALE · DATE OCTOBER 1970

DRAWING NUMBER LM 52-12.4/1

PLATE I

RECORD DRAWING "AS BUILT"

CORPS OF ENGINEERS



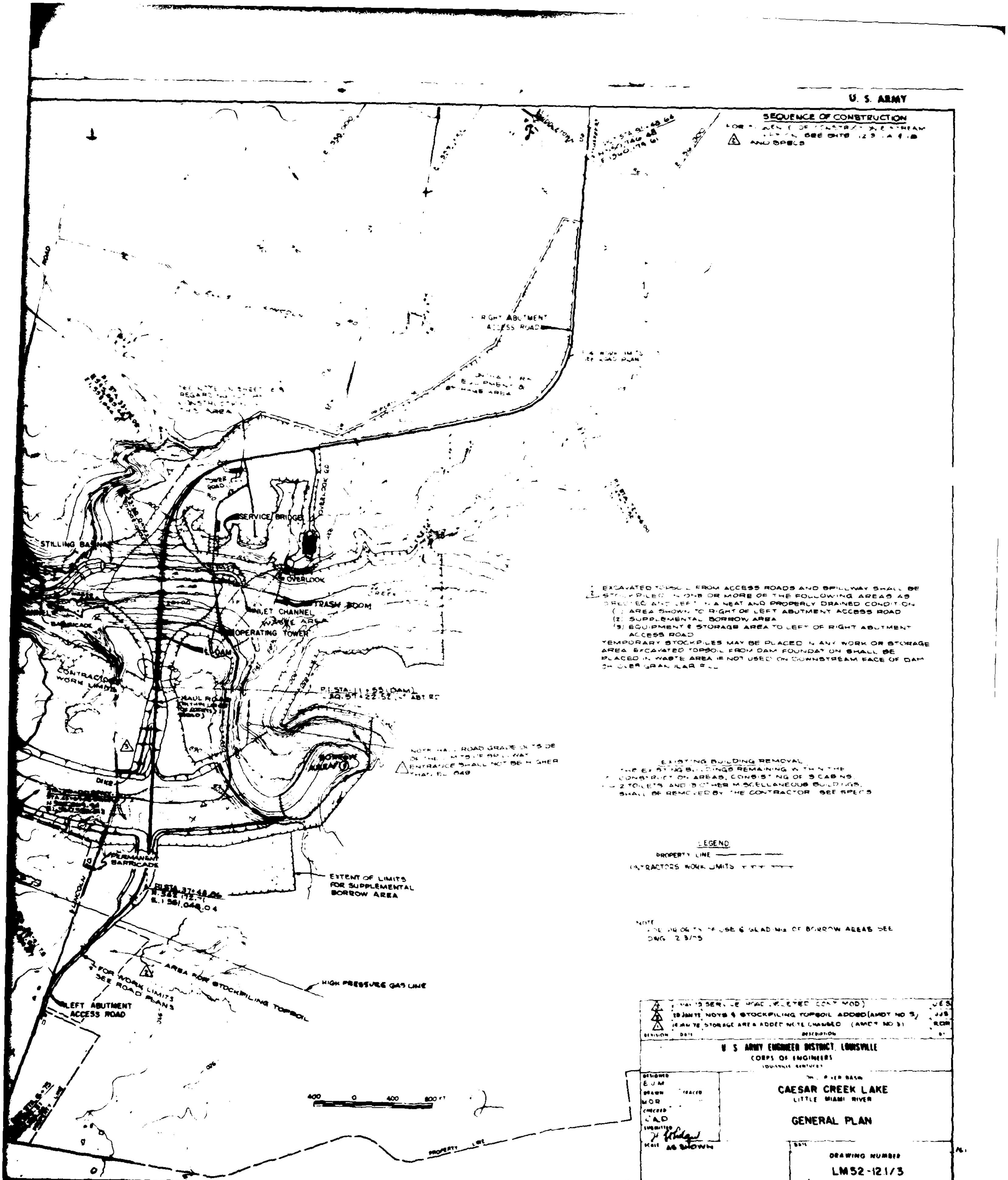
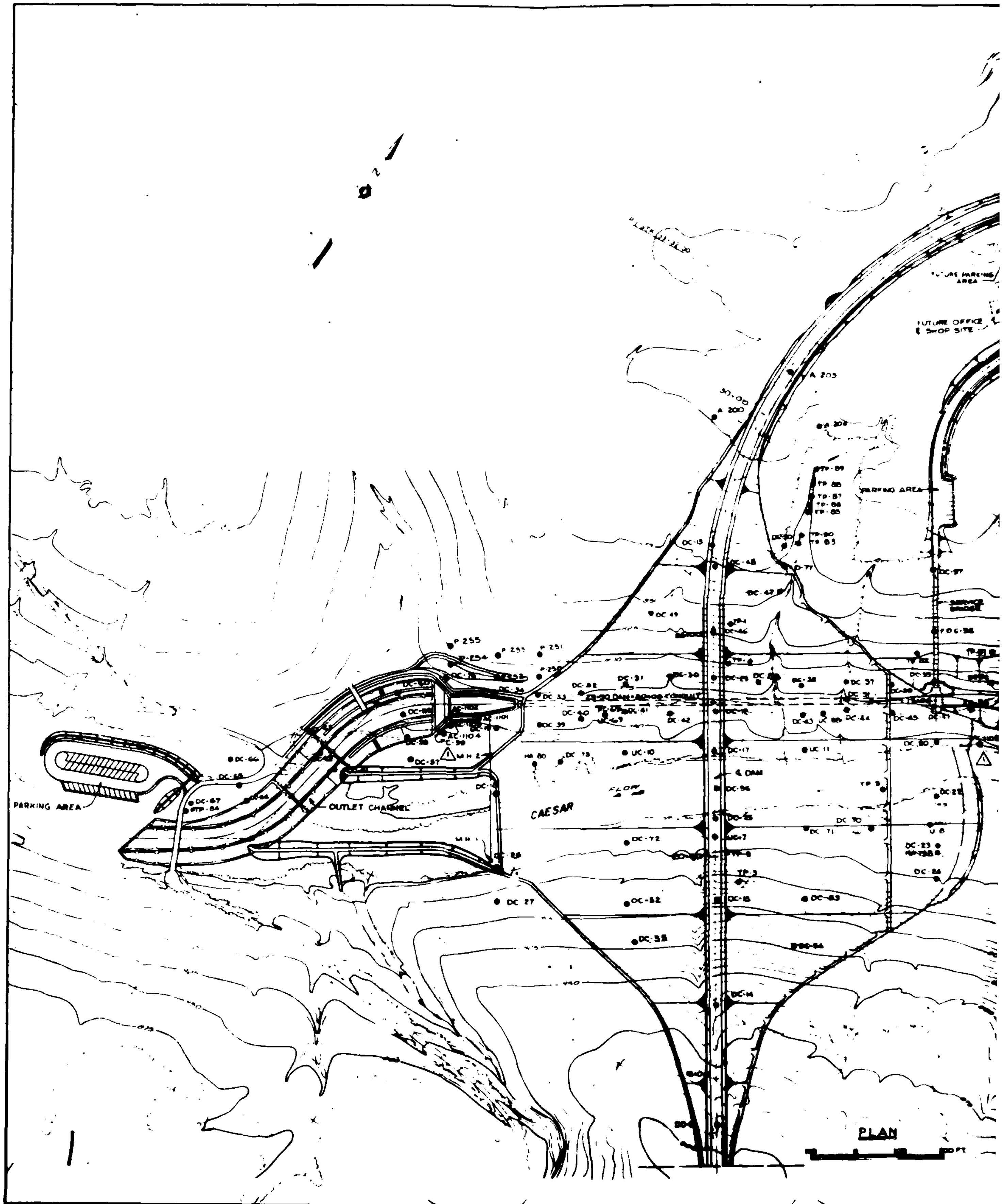

U. S. ARMY
SEQUENCE OF CONSTRUCTION
AND SPECS
RIGHT ABUTMENT ACCESS ROAD
SERVICE BRIDGE
STILLING BASIN
OVERLOOK
TRASH BOOM
INLET CHANNEL
OPERATING TOWER
CONTRACTORS WORK LIMITS
HAUL ROAD
P.I. STA. 11+55 (DAM)
BORROW AREA
DIKE
PERMANENT BARRICADE
EXTENT OF LIMITS FOR SUPPLEMENTAL BORROW AREA
AREA FOR STOCKPILING TOPSOIL
FOR WORK LIMITS SEE ROAD PLANS
HIGH PRESSURE GAS LINE
LEFT ABUTMENT ACCESS ROAD
PROPERTY LINE
EXCAVATED TOPSOIL FROM ACCESS ROADS AND SPILLWAY SHALL BE STOCKPILED IN ONE OR MORE OF THE FOLLOWING AREAS AS DIRECTED AND LEFT IN A NEAT AND PROPERLY DRAINED CONDITION
(1) AREA SHOWN TO RIGHT OF LEFT ABUTMENT ACCESS ROAD
(2) SUPPLEMENTAL BORROW AREA
(3) EQUIPMENT & STORAGE AREA TO LEFT OF RIGHT ABUTMENT ACCESS ROAD
TEMPORARY STOCKPILES MAY BE PLACED IN ANY WORK OR STORAGE AREA. EXCAVATED TOPSOIL FROM DAM FOUNDATION SHALL BE PLACED IN WASTE AREA IF NOT USED ON DOWNSTREAM FACE OF DAM OR OVER GRANULAR FILL
EXISTING BUILDING REMOVAL
LEGEND
PROPERTY LINE
CONTRACTORS WORK LIMITS
NOTE
DWG 2 3/75
SERVICE ROAD DELETED (CONT MOD)
NOTE & STOCKPILING TOPSOIL ADDED (AMDT NO 3)
STORAGE AREA ADDED NOTE CHANGED (AMDT NO 1)
REVISION
DATE
DESCRIPTION
U S ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
DESIGNED
EJM
DRAWN
MOR
CHECKED
CAD
SUBMITTED
SCALE AS SHOWN
CAESAR CREEK LAKE
LITTLE MIAMI RIVER
GENERAL PLAN
DRAWING NUMBER
LM52-121/3
400 0 400 800 FT

PLATE 2


PARKING AREA
OUTLET CHANNEL
CAESAR
FLOW
PARKING AREA
FUTURE OFFICE & SHOP SITE
SERVICE BRIDGE
PLAN

U. S. ARMY

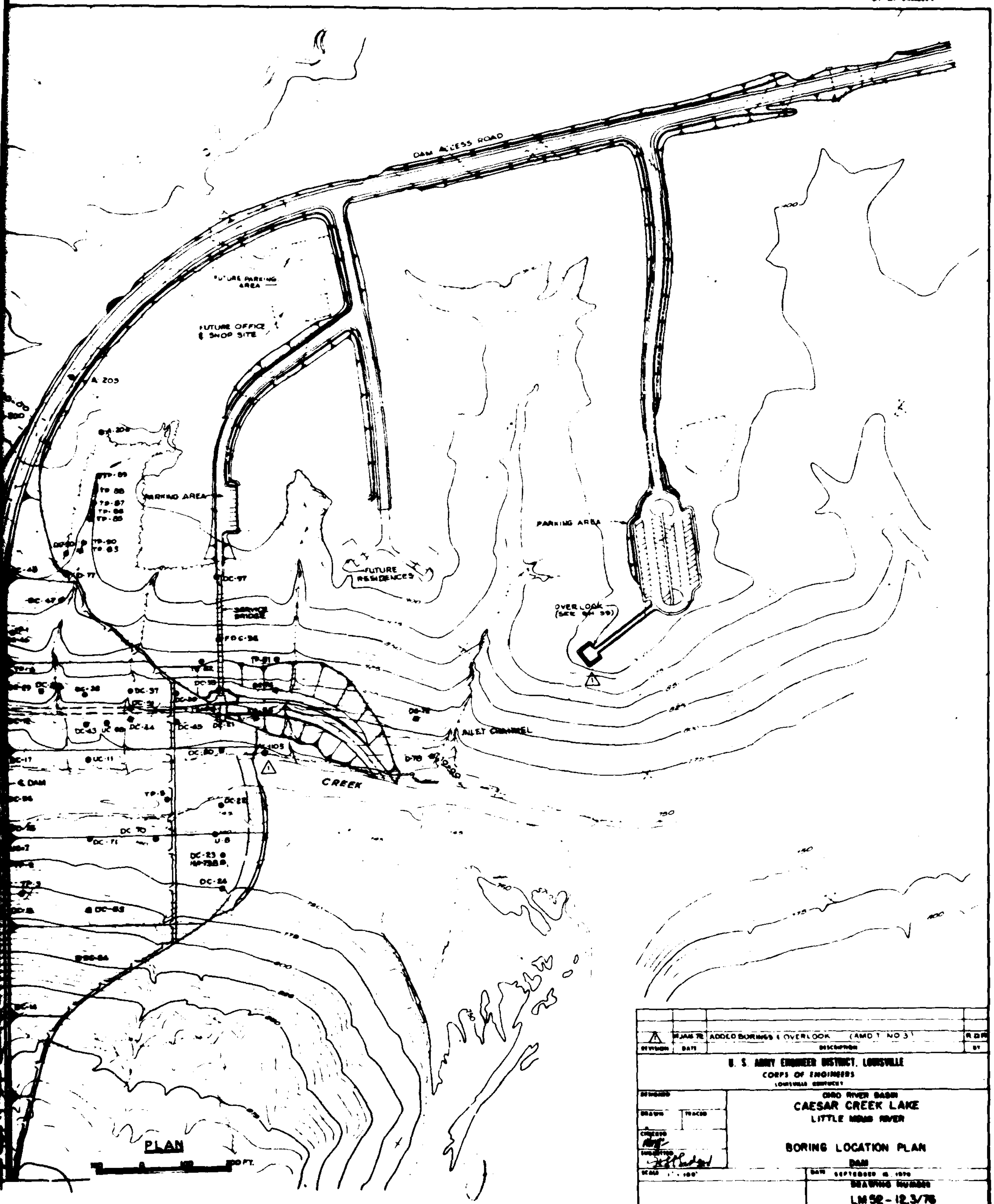
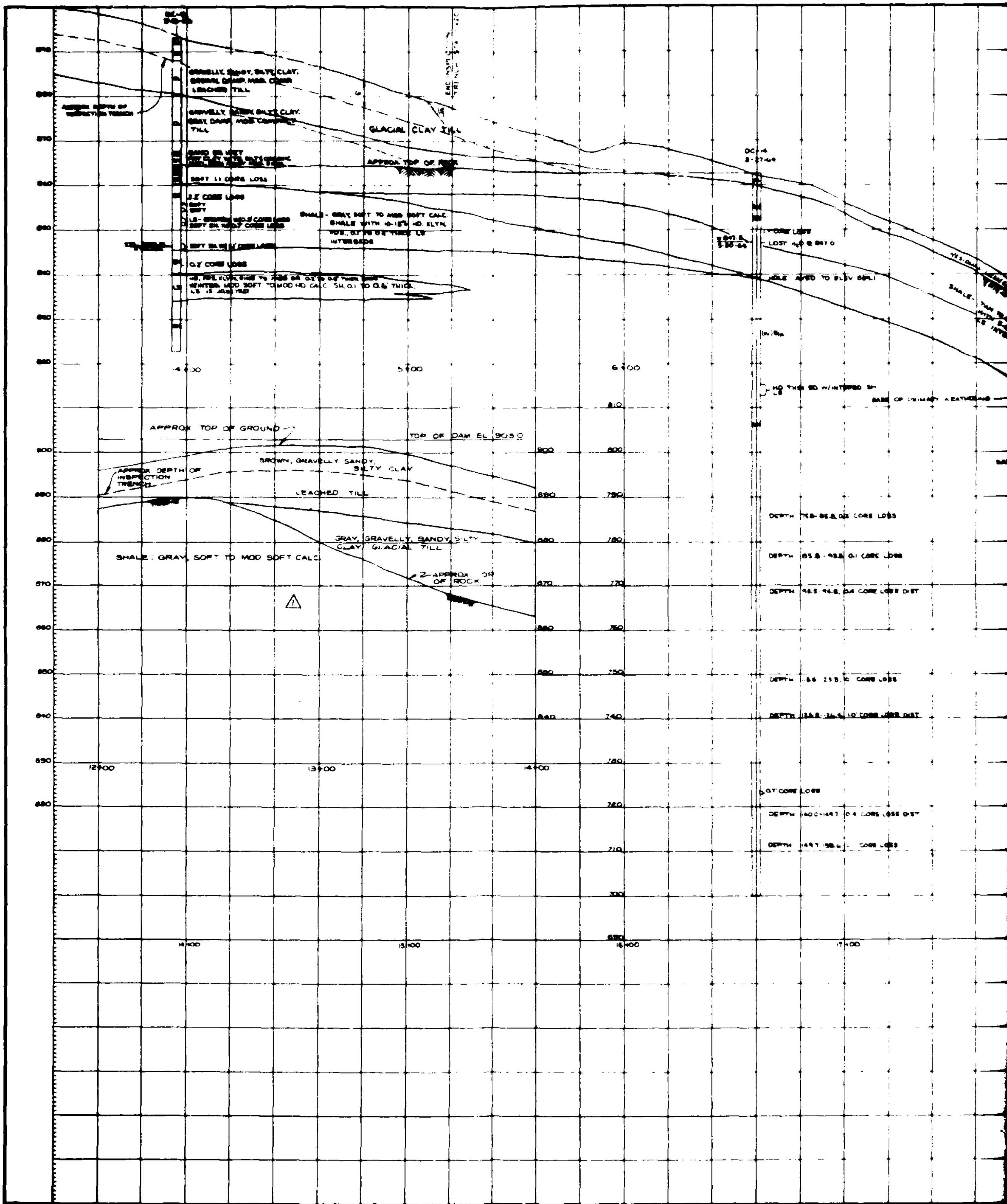



PLATE 3

CORPS OF ENGINEERS



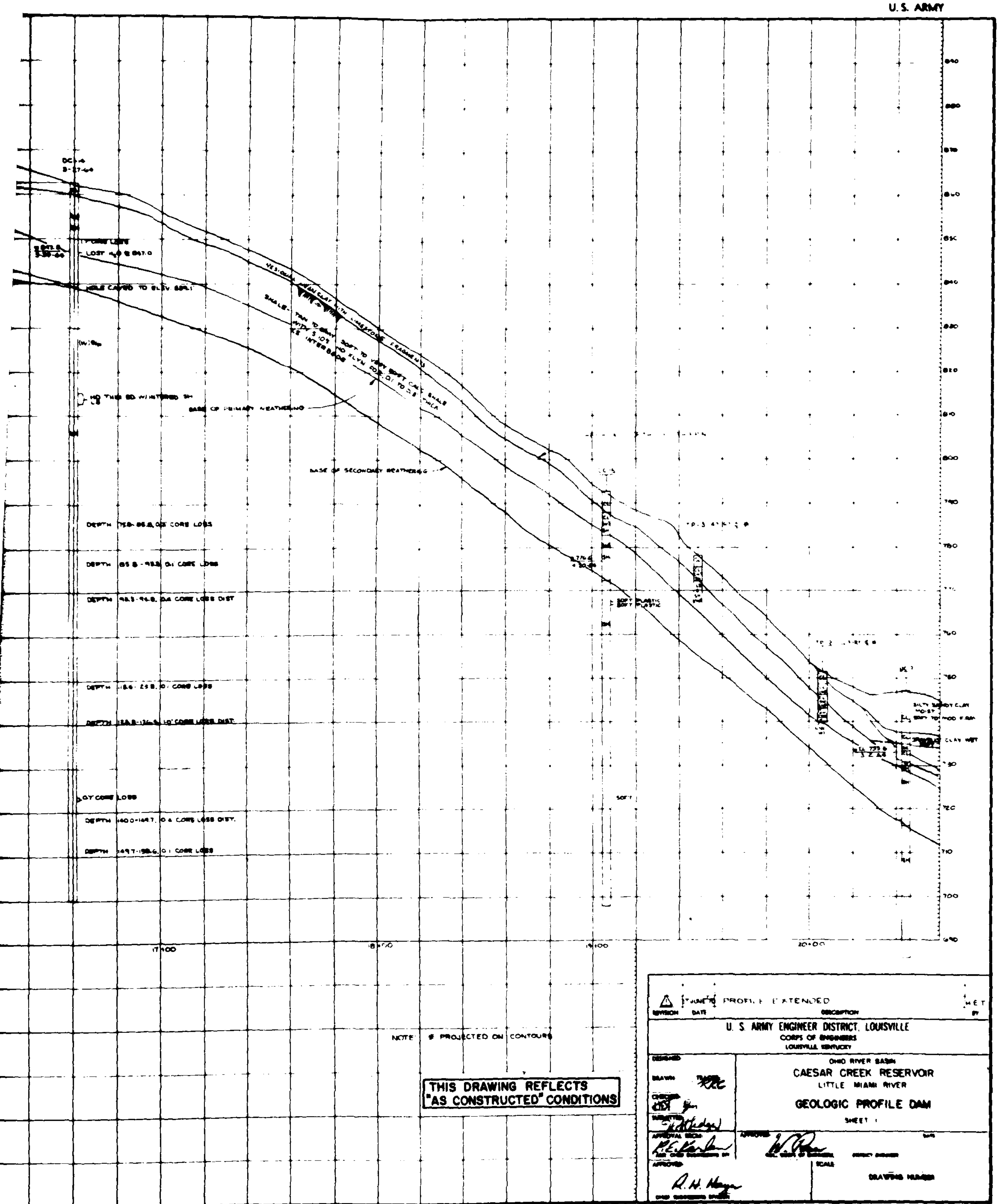
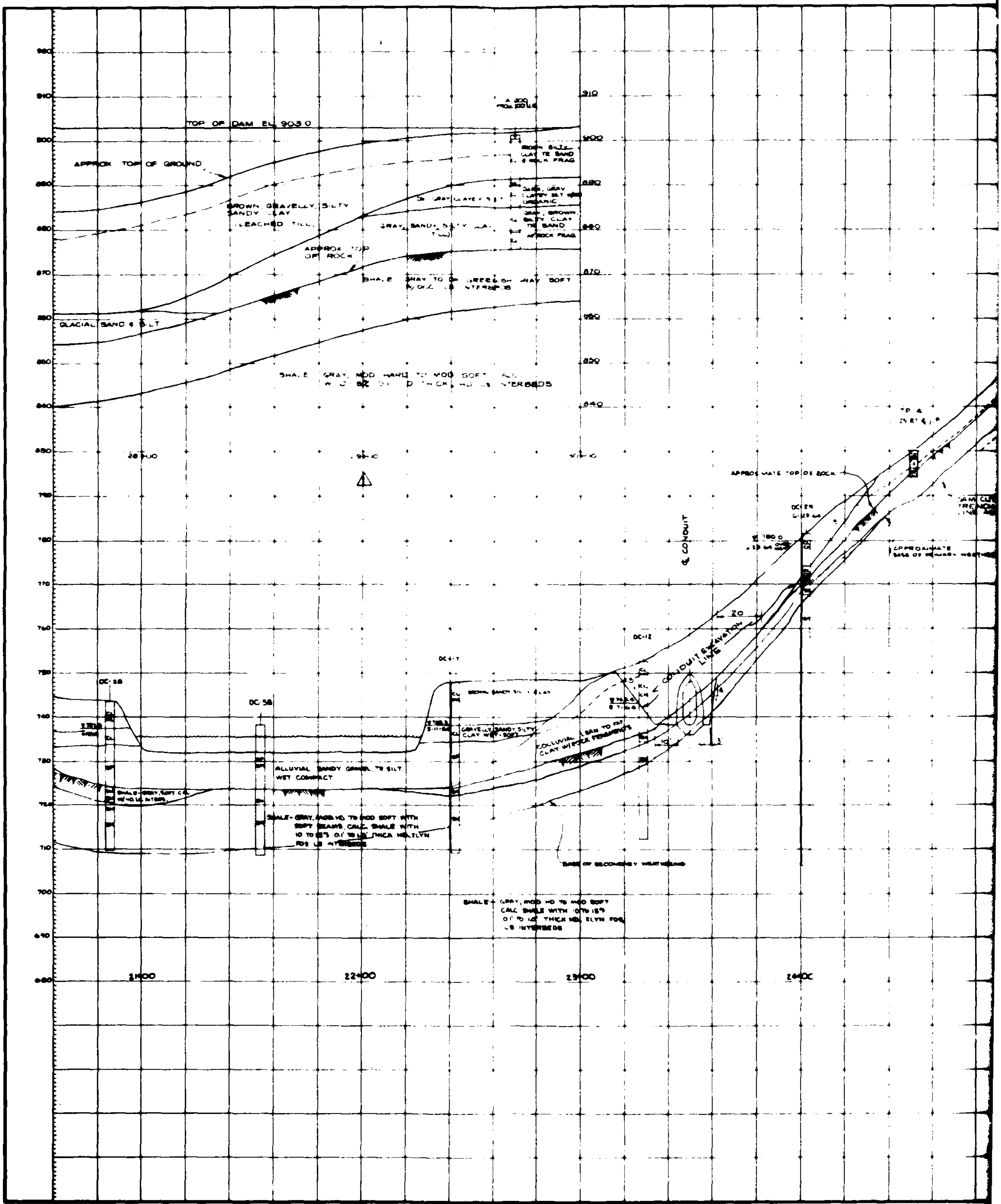
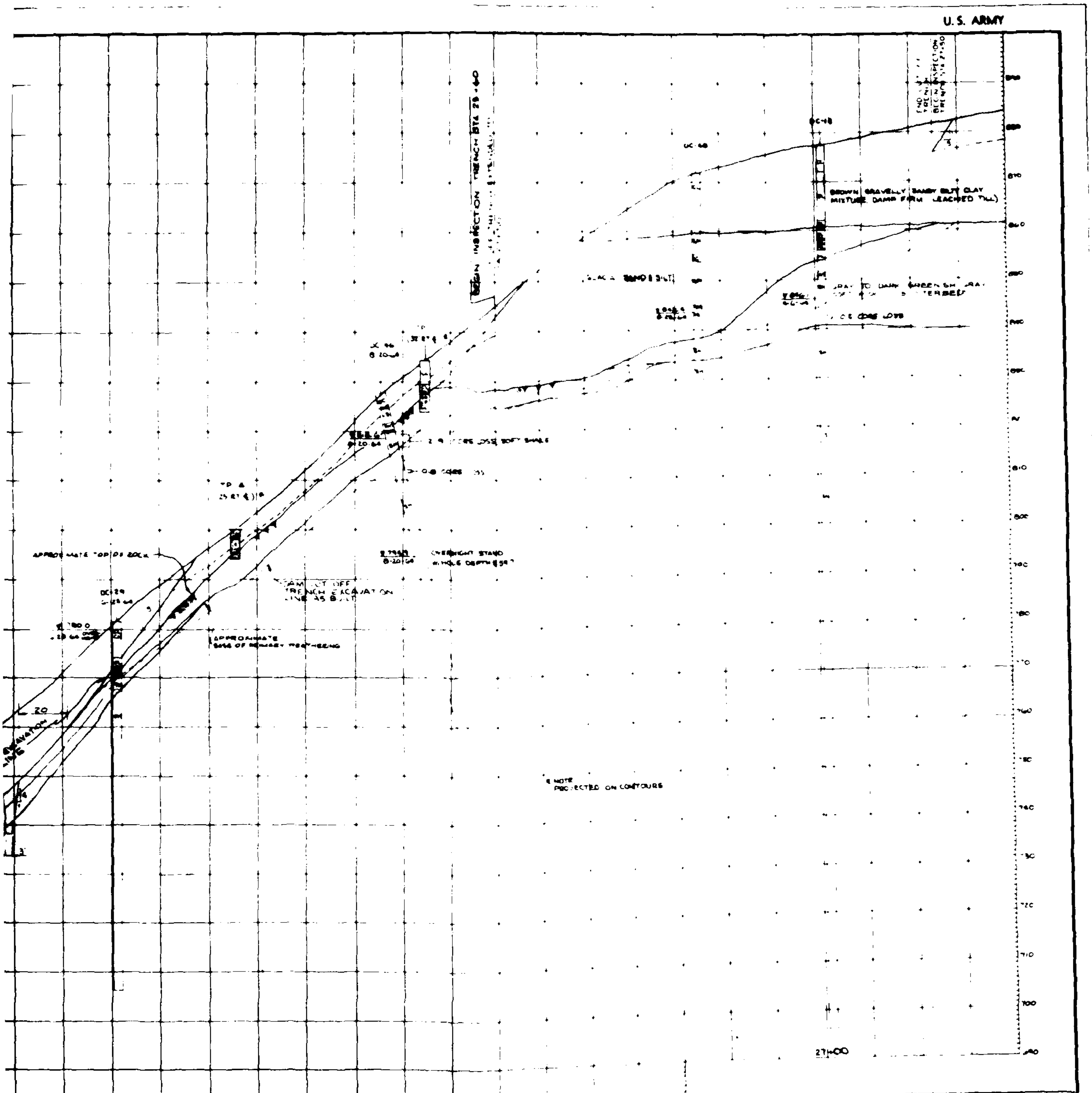

U.S. ARMY
DC-4
LOST
HOLE CAVED TO ELEV.
HO THIS 20 WEATHERED SH
BASE OF PRIMARY WEATHERING
BASE OF SECONDARY WEATHERING
SHALE - TAN TO GRAY, SOFT TO VERY SOFT CALC SHALE WITH 5-10% HD ELYN LS INTERBEDS
DEPTH 75.5-85.5, 0.5' CORE LOSS
DEPTH 85.5-95.5, 0.1 CORE LOSS
DEPTH 95.5-96.5, 0.4 CORE LOSS DIST
DEPTH 126.5-134.5, 1.0' CORE LOSS DIST
CORE LOSS
DEPTH 140.0-149.7, 0.6 CORE LOSS DIST.
DEPTH 149.7-158.6, 0.1 CORE LOSS
SOFT PLASTIC
SOFT
SILTY SANDY CLAY MOIST SOFT TO MOD FIRM
CLAY WET
17+00
18+00
19+00
20+00
NOTE: # PROJECTED ON CONTOURS
THIS DRAWING REFLECTS "AS CONSTRUCTED" CONDITIONS
PROFILE EXTENDED
REVISION
DATE
DESCRIPTION
BY
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
DESIGNED
DRAWN
TRACED
CHECKED
SUBMITTED
APPROVAL RECOM.
APPROVED
OHIO RIVER BASIN
CAESAR CREEK RESERVOIR
LITTLE MIAMI RIVER
GEOLOGIC PROFILE DAM
SHEET 1
SCALE
DRAWING NUMBER

PLATE 4

CORPS OF ENGINEERS



U. S. ARMY




PROFILE EXTENDED

REVISION | DATE | DESCRIPTION

U S ARMY ENGINEER DISTRICT, LOUISVILLE

CORPS OF ENGINEERS

LOUISVILLE, KENTUCKY

OHIO RIVER BASIN

CAESAR CREEK RESERVOIR

LITTLE MIAMI RIVER

GEOLOGIC PROFILE DAM

SHEET 2

DESIGNED

DRAWN TRACED

CHECKED

SUBMITTED

APPROVAL RECOM

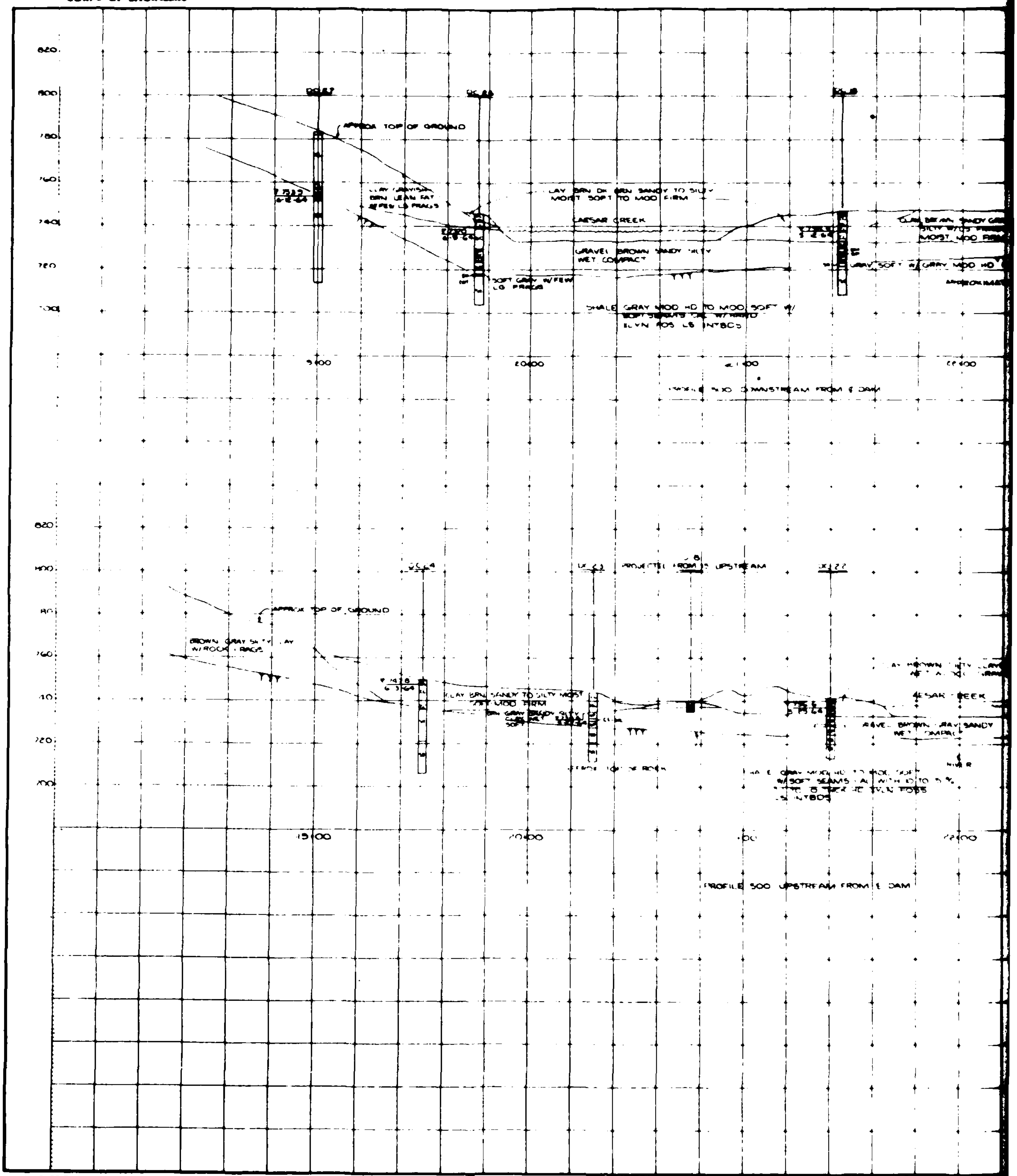
APPROVED

SCALE

DRAWING NUMBER

PLATE 5

CORPS OF ENGINEERS



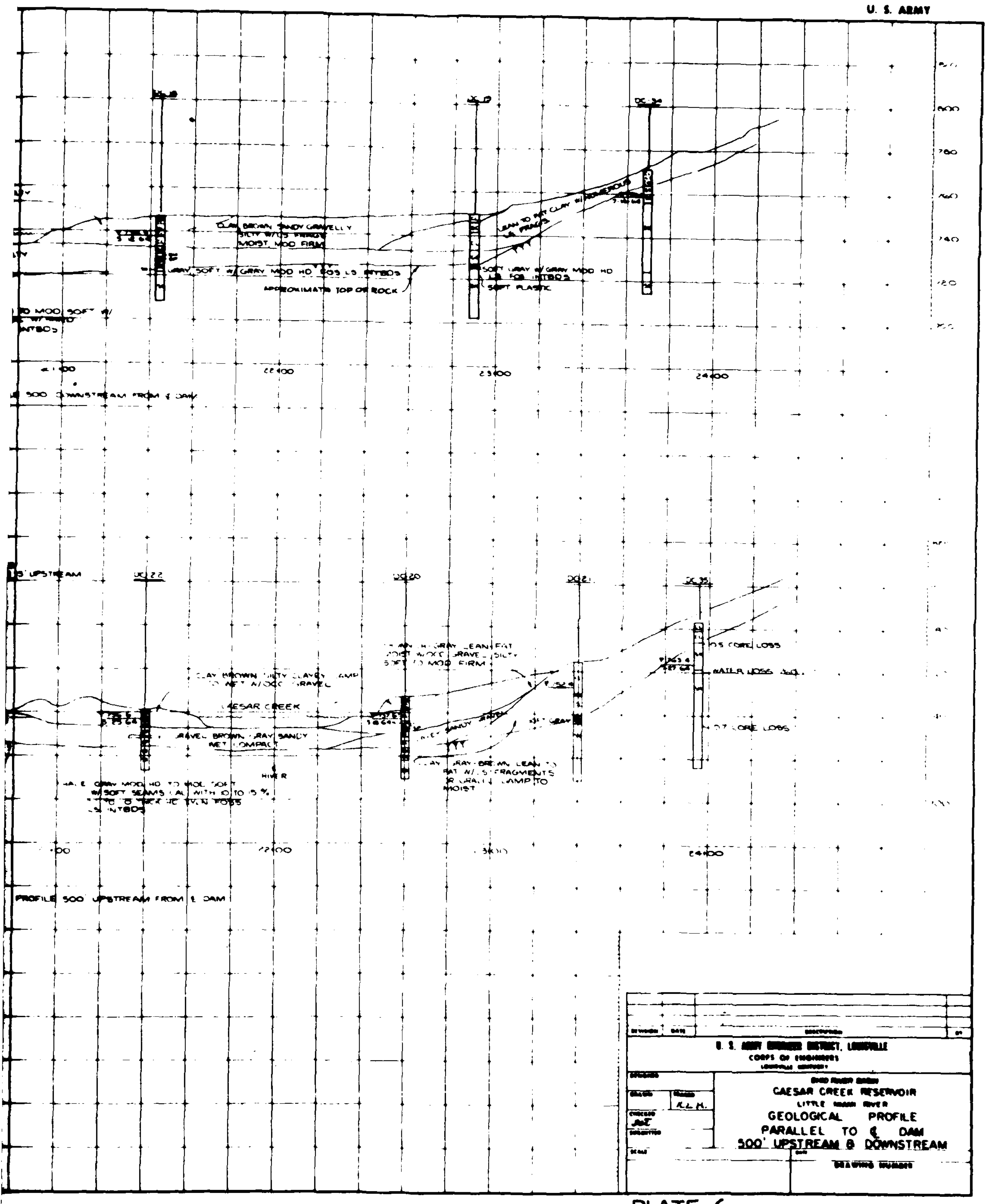
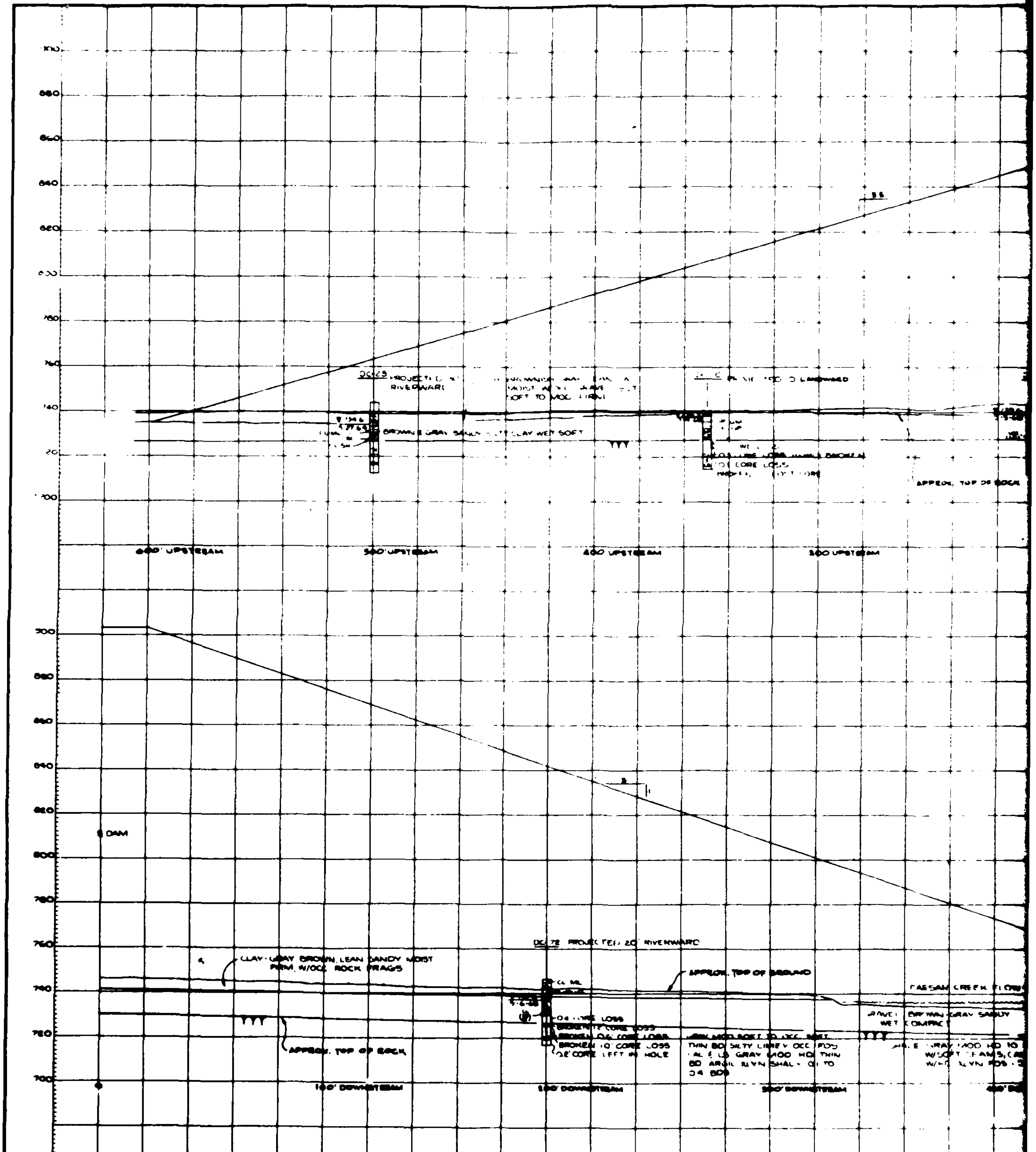

U. S. ARMY
CLAY BROWN SANDY GRAVELLY
SILTY W/LS FRAGS
MOIST MOD FIRM
LEAN TO FAT CLAY W/ NUMEROUS
LS FRAGS
SOFT GRAY W/ GRAY MOD HD
LS FOS INTBDS
SOFT PLASTIC
APPROXIMATE TOP OF ROCK
22400
23100
24400
500 DOWNSTREAM FROM ℄ DAM
DC 22
DC 20
DC 21
DC 35
0.5 CORE LOSS
0.7 CORE LOSS
CAESAR CREEK
GRAVEL BROWN GRAY SANDY
WET COMPACT
RIVER
MOIST
22400
24400
PROFILE 500 UPSTREAM FROM ℄ DAM
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
CAESAR CREEK RESERVOIR
LITTLE MIAMI RIVER
GEOLOGICAL PROFILE
PARALLEL TO ℄ DAM
500' UPSTREAM & DOWNSTREAM
R.L.H.
DRAWING NUMBER

PLATE 6

CORPS OF ENGINEERS



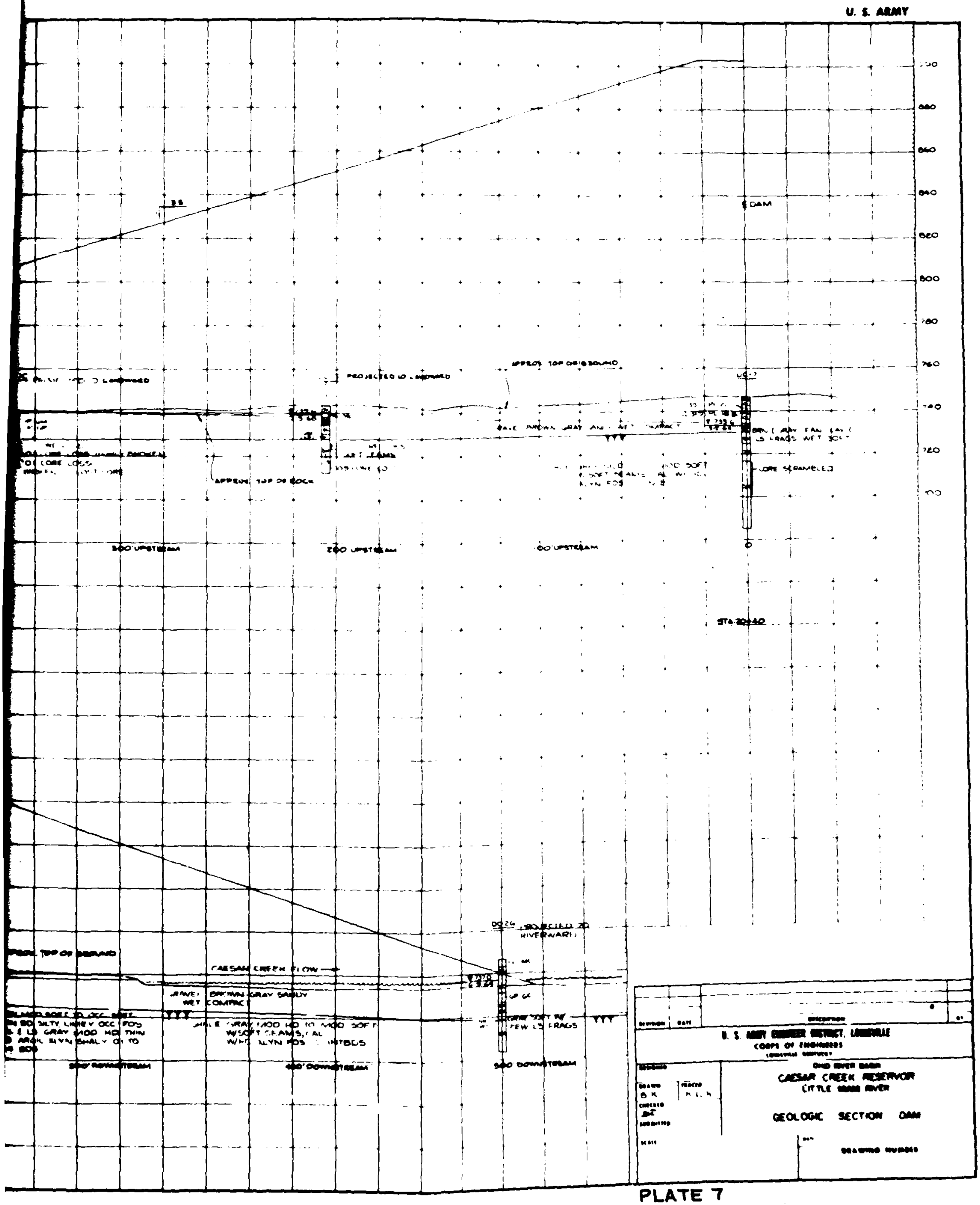
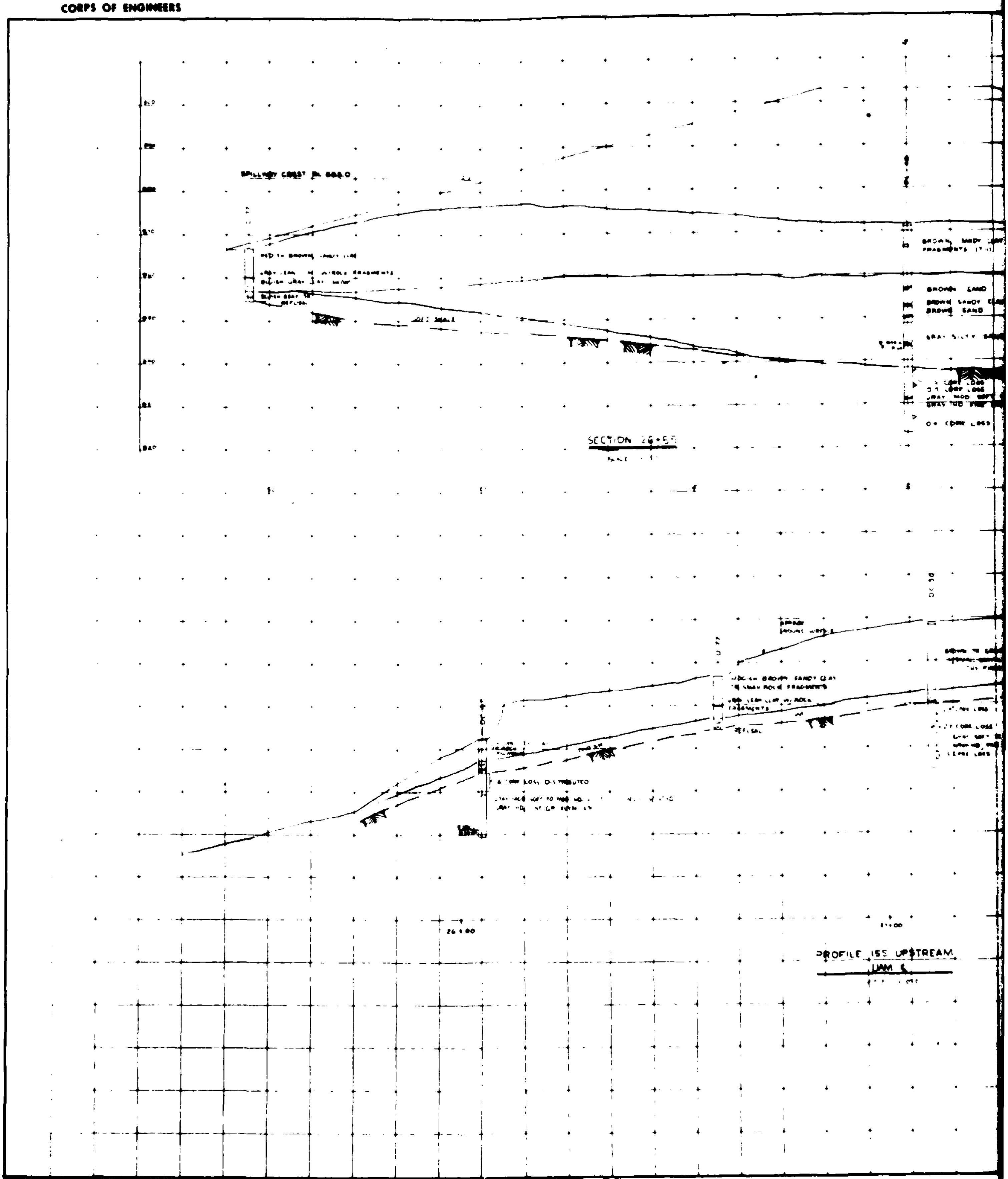
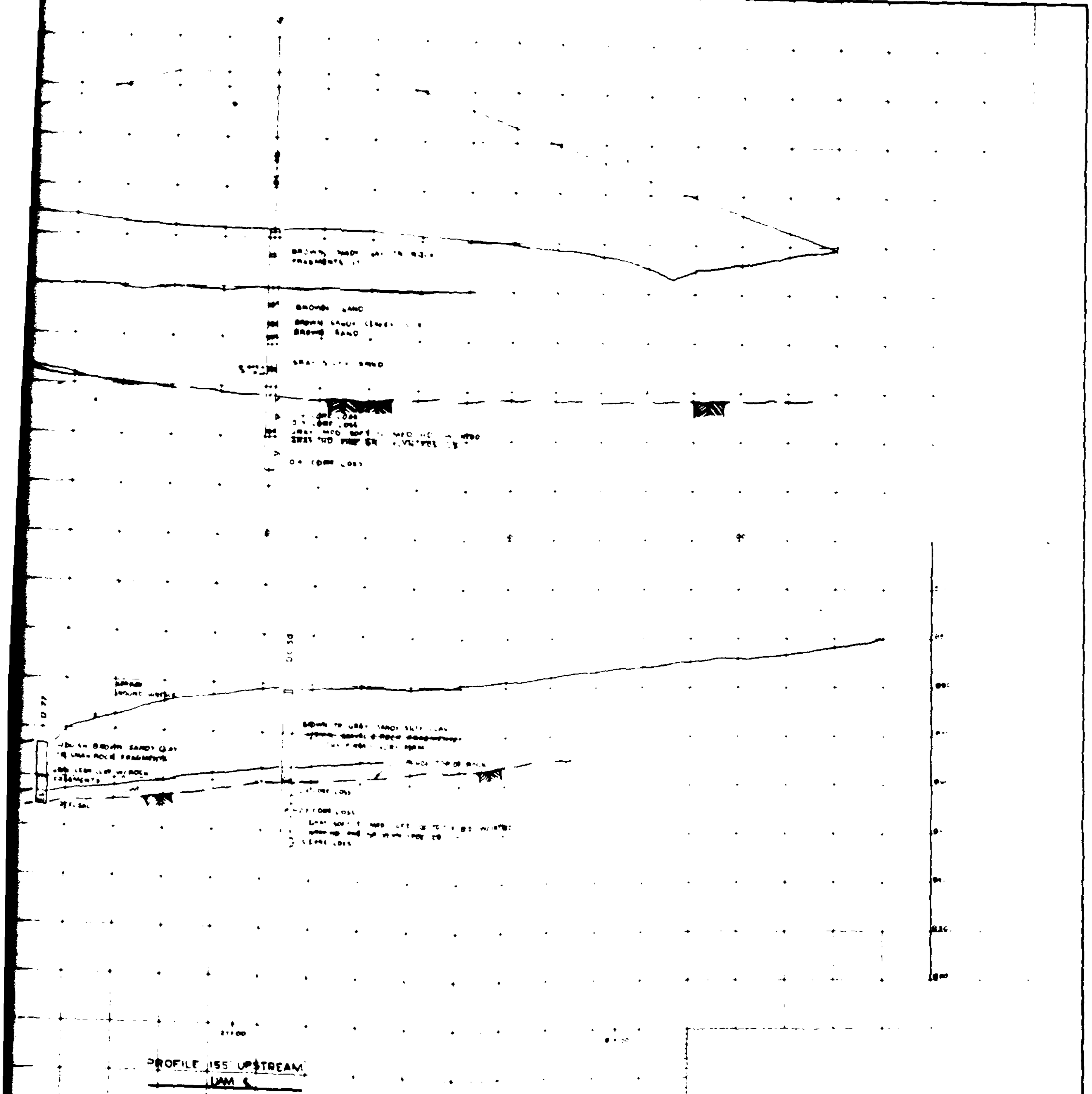

U. S. ARMY
DAM
880
860
840
820
800
780
760
740
720
700
APPROX TOP ORIG GROUND
PROJECTED 10 LANDWARD
APPROX TOP OF ROCK
CORE SCRAMBLED
300 UPSTREAM
200 UPSTREAM
100 UPSTREAM
STA 20+40
PROJECTED TO RIVERWARD
CAESAR CREEK FLOW
GRAVEL BROWN-GRAY SANDY
WET COMPACT
300 DOWNSTREAM
400 DOWNSTREAM
500 DOWNSTREAM
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
CAESAR CREEK RESERVOIR
GEOLOGIC SECTION DAM
DRAWING NUMBER

PLATE 7

CORPS OF ENGINEERS



U. S. ARMY

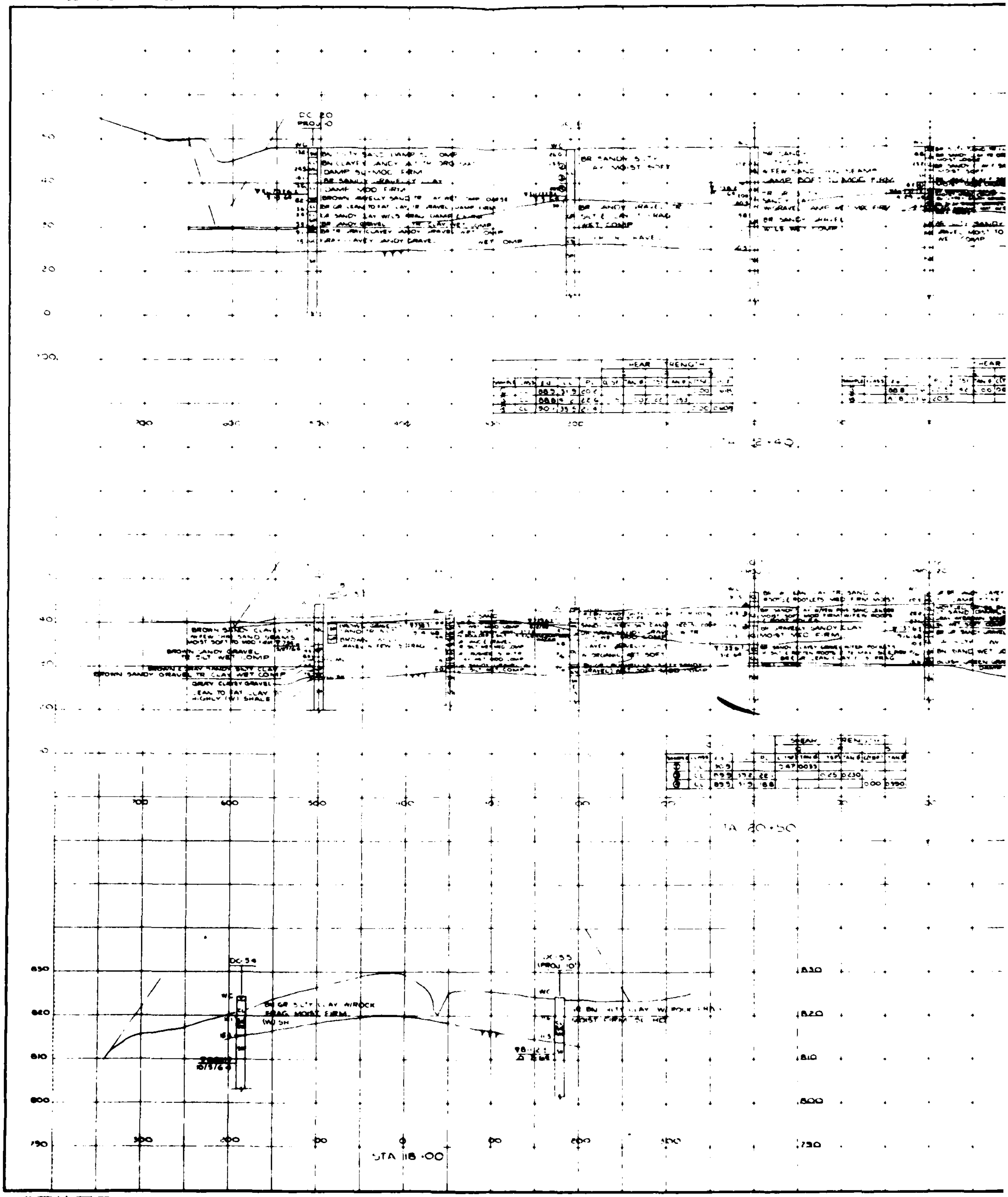



U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE KENTUCKY

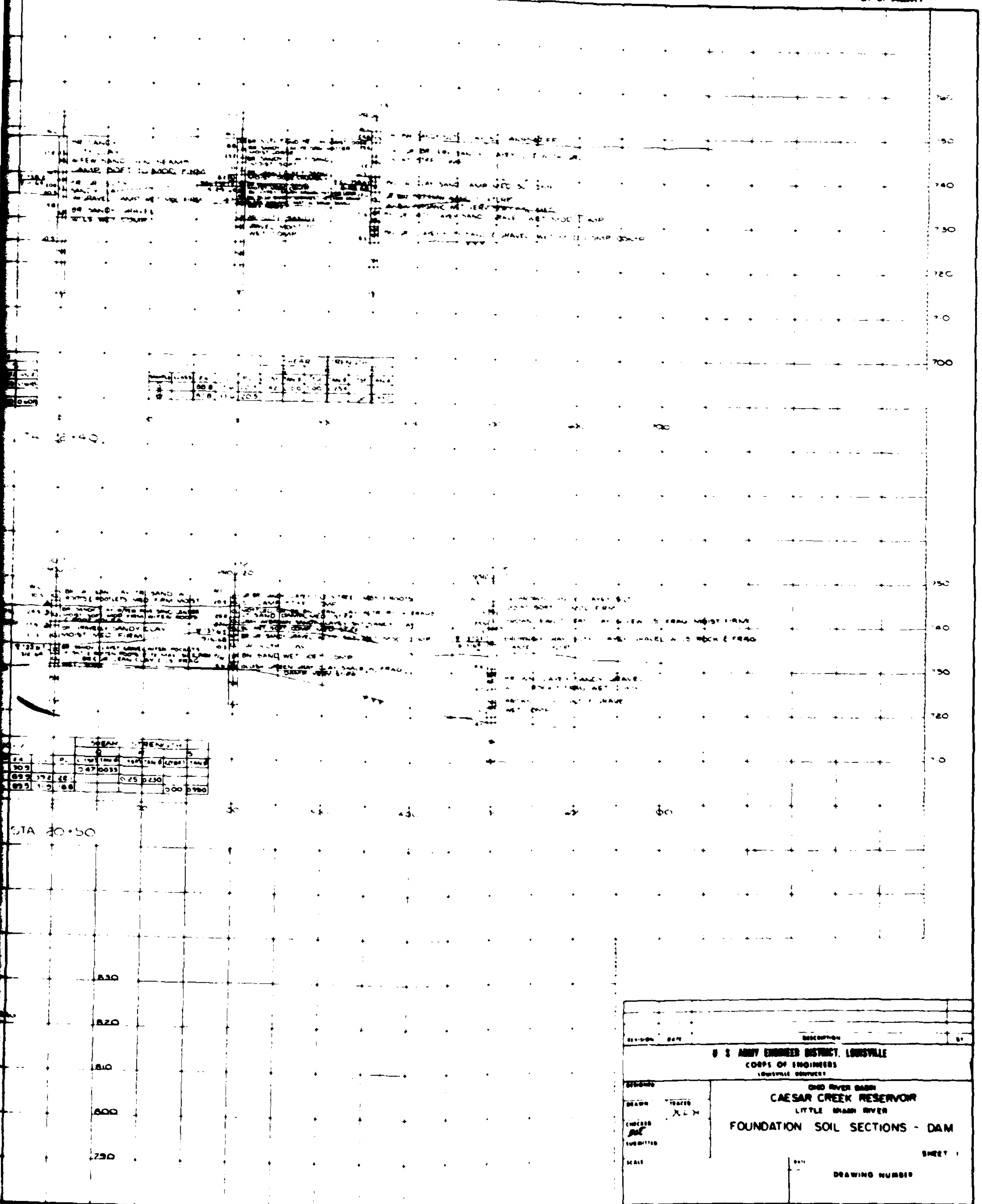
OHIO RIVER BASIN
CAESAR CREEK RESERVOIR
LITTLE MIAMI RIVER
RIGHT ABUTMENT
GEOLOGIC PROFILE & SECTION

DRAWING NUMBER

PLATE 8


BROWN SANDY GRAVEL
BROWN SANDY GRAVEL TR SILT WET COMP
GRAY CLAYEY GRAVEL
LEAN TO FAT CLAY TO HIGHLY (W) SHALE
DC-54
(PROJ 10')
BR GR SILTY CLAY W/ROCK FRAG MOIST FIRM (W) SH
830
820
810
800
790
STA 118+00

U. S. ARMY




U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

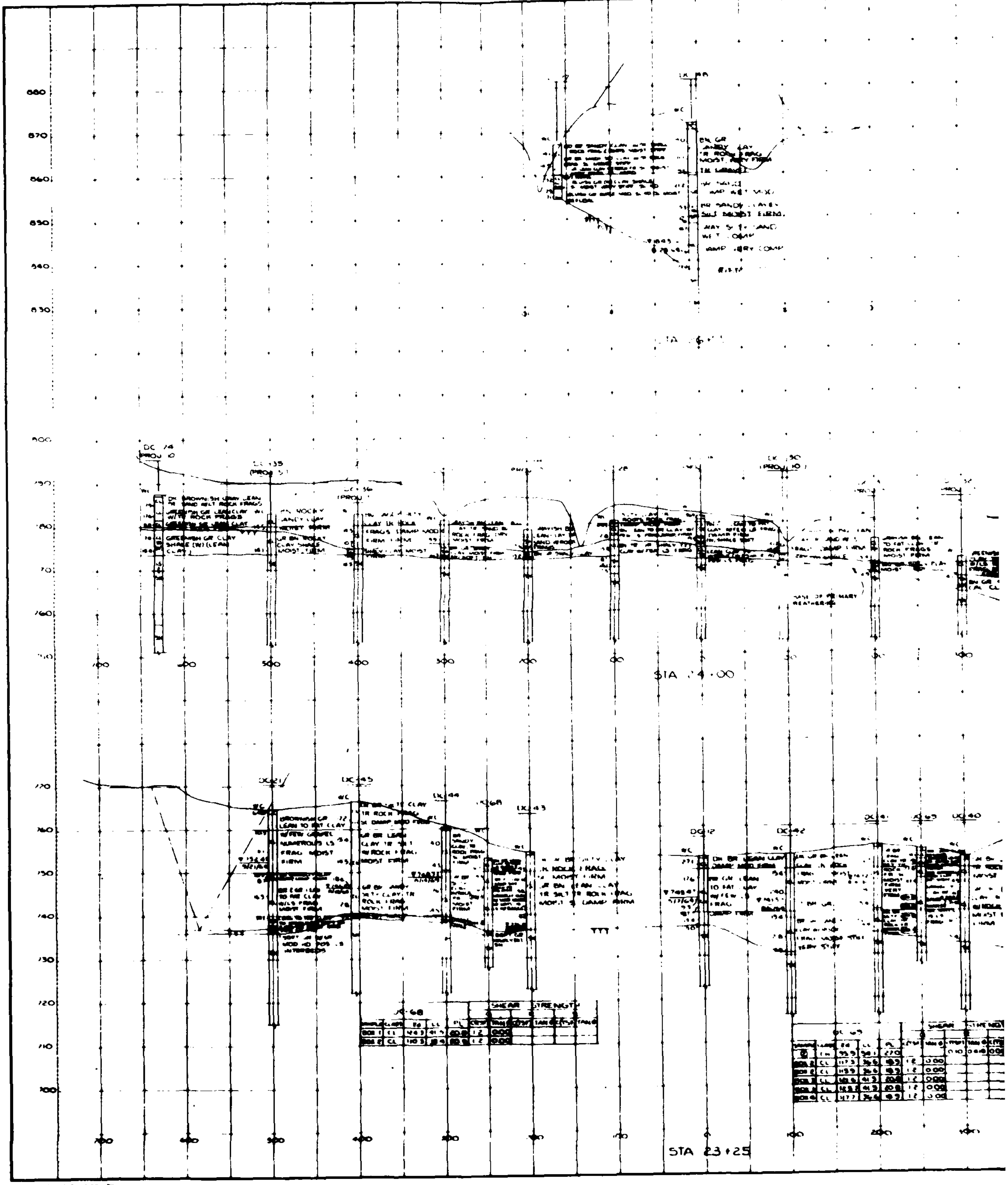
OHIO RIVER BASIN
CAESAR CREEK RESERVOIR
LITTLE MIAMI RIVER
FOUNDATION SOIL SECTIONS - DAM

SHEET 1

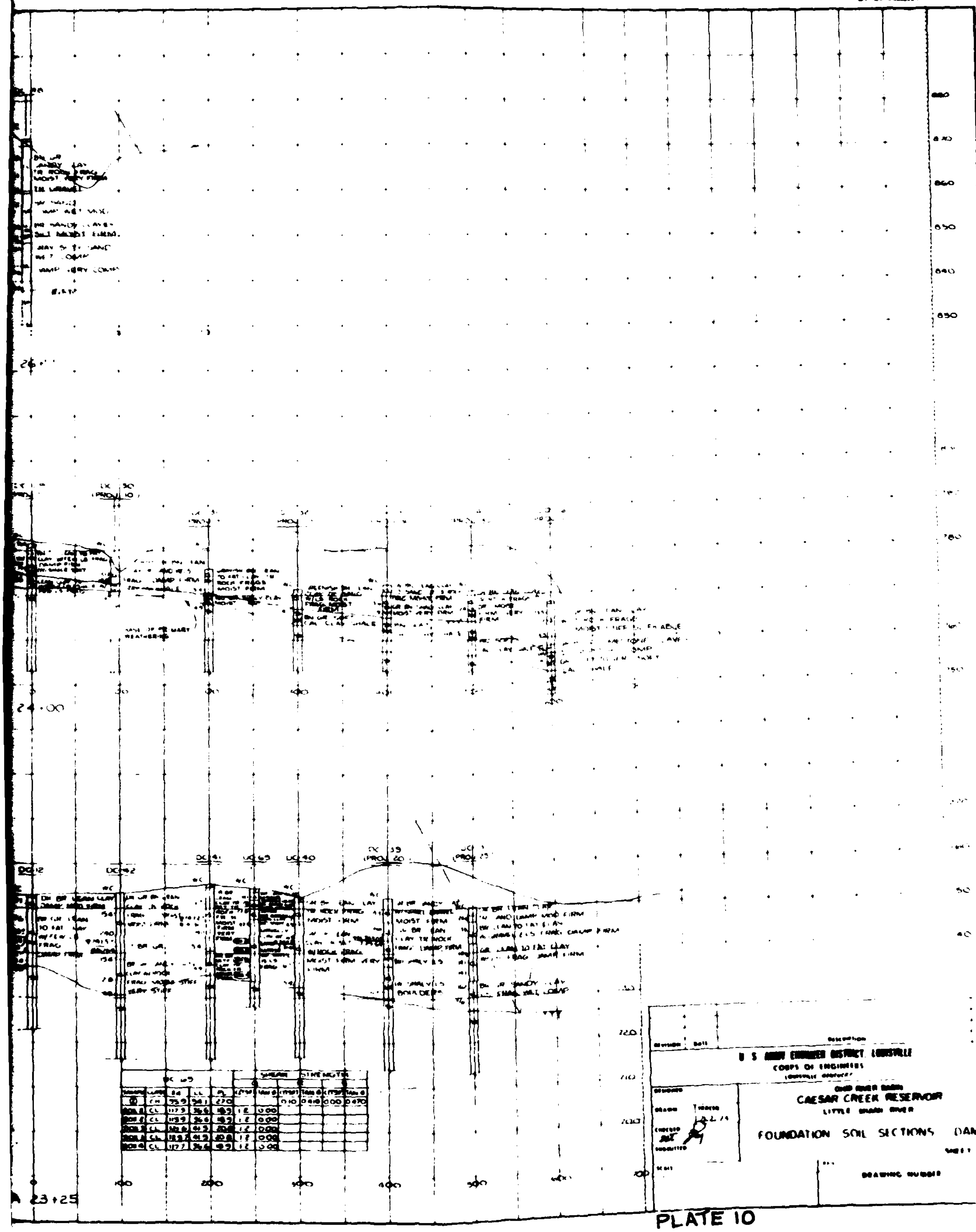
DRAWING NUMBER

PLATE 9

CORPS OF ENGINEERS



U. S. ARMY



| | DC 45 | | | | Shear Strength | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | LL | PL | C (TSF) | Tan φ | C (TSF) | Tan φ | C (TSF) | Tan φ |
| [illegible] | CH | 75.9 | 56.1 | 27.0 | | | 0.10 | 0.410 | 0.00 | 0.470 |
| [illegible] | CL | 117.9 | 36.6 | 19.9 | 1.2 | 0.00 | | | | |
| [illegible] | CL | 115.9 | 36.6 | 19.9 | 1.2 | 0.00 | | | | |
| [illegible] | CL | 121.6 | 41.9 | 20.8 | 1.2 | 0.00 | | | | |
| [illegible] | CL | 123.7 | 41.9 | 20.8 | 1.2 | 0.00 | | | | |
| [illegible] | CL | 117.7 | 36.6 | 19.9 | 1.2 | 0.00 | | | | |

U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS

OHIO RIVER BASIN
CAESAR CREEK RESERVOIR
LITTLE MIAMI RIVER

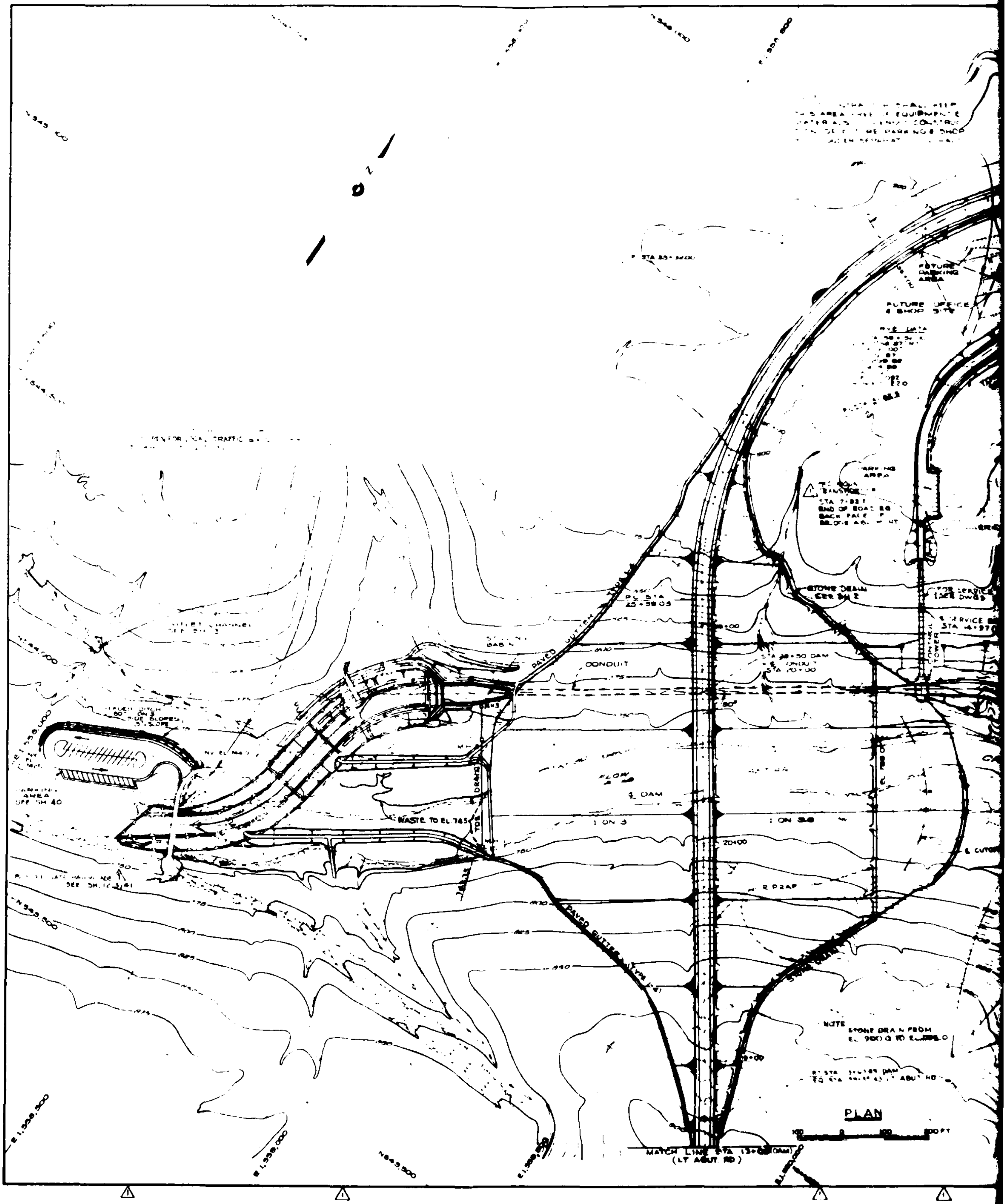
FOUNDATION SOIL SECTIONS DAM

SHEET 2

DRAWING NUMBER

PLATE 10

CORPS OF ENGINEERS



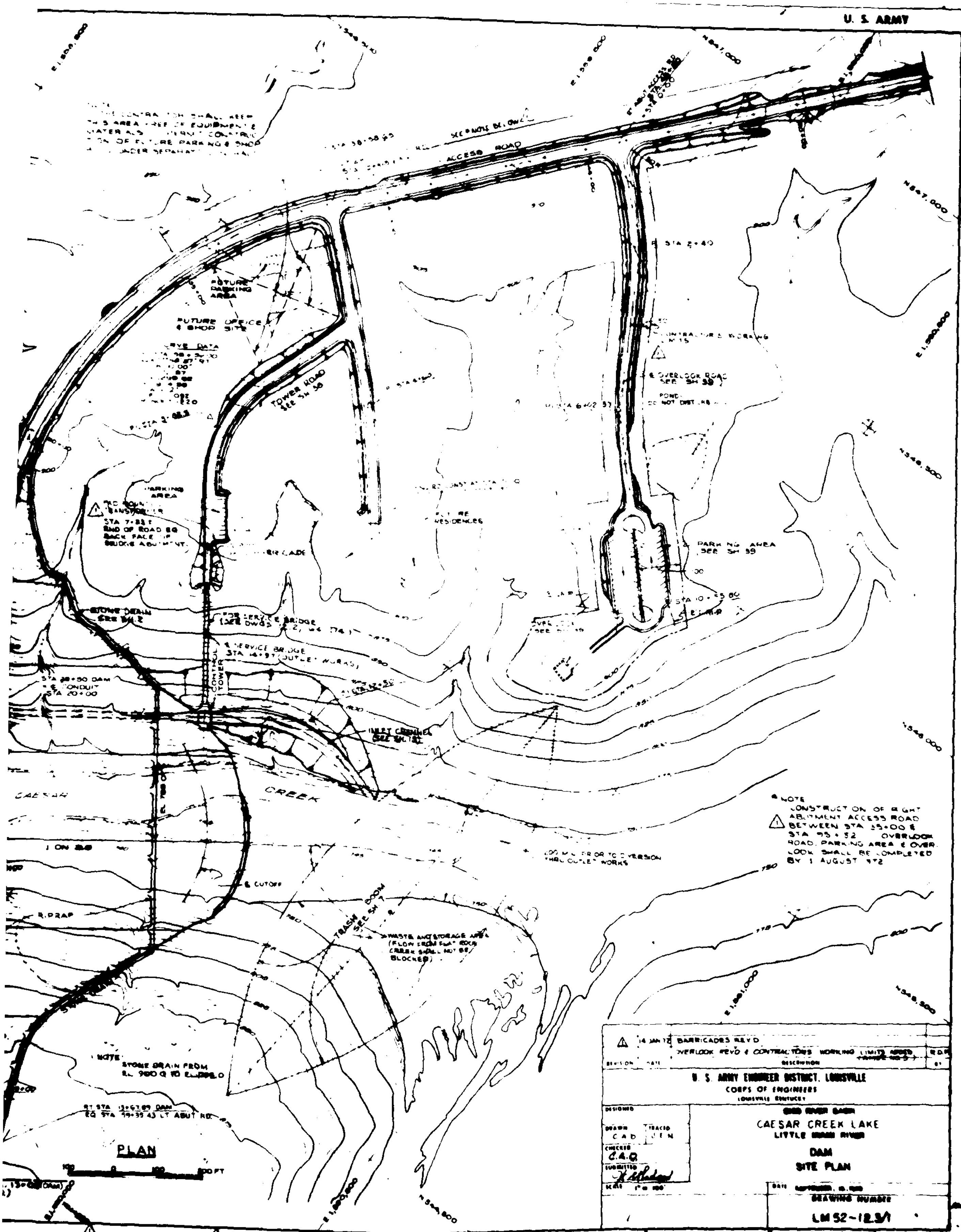
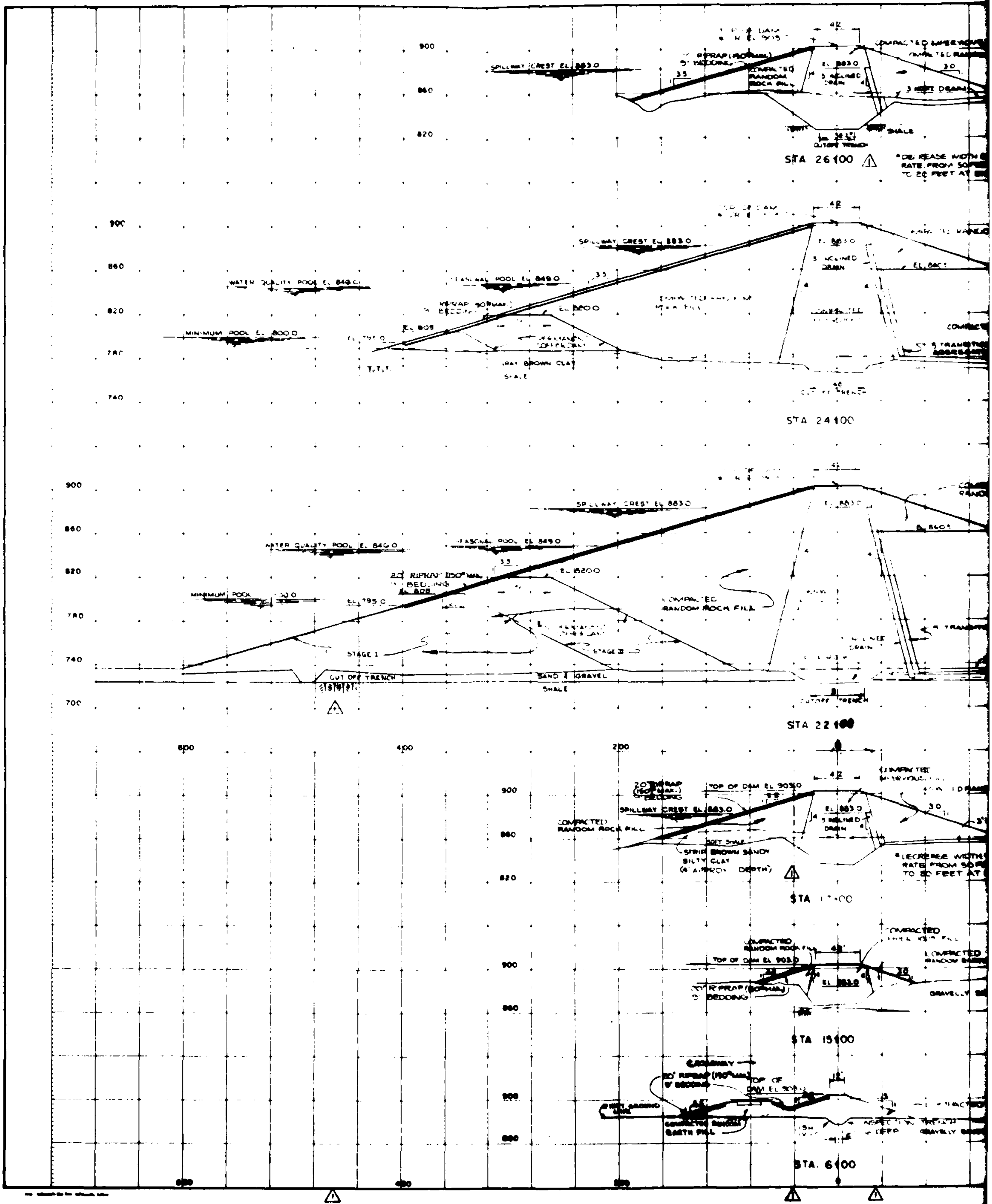
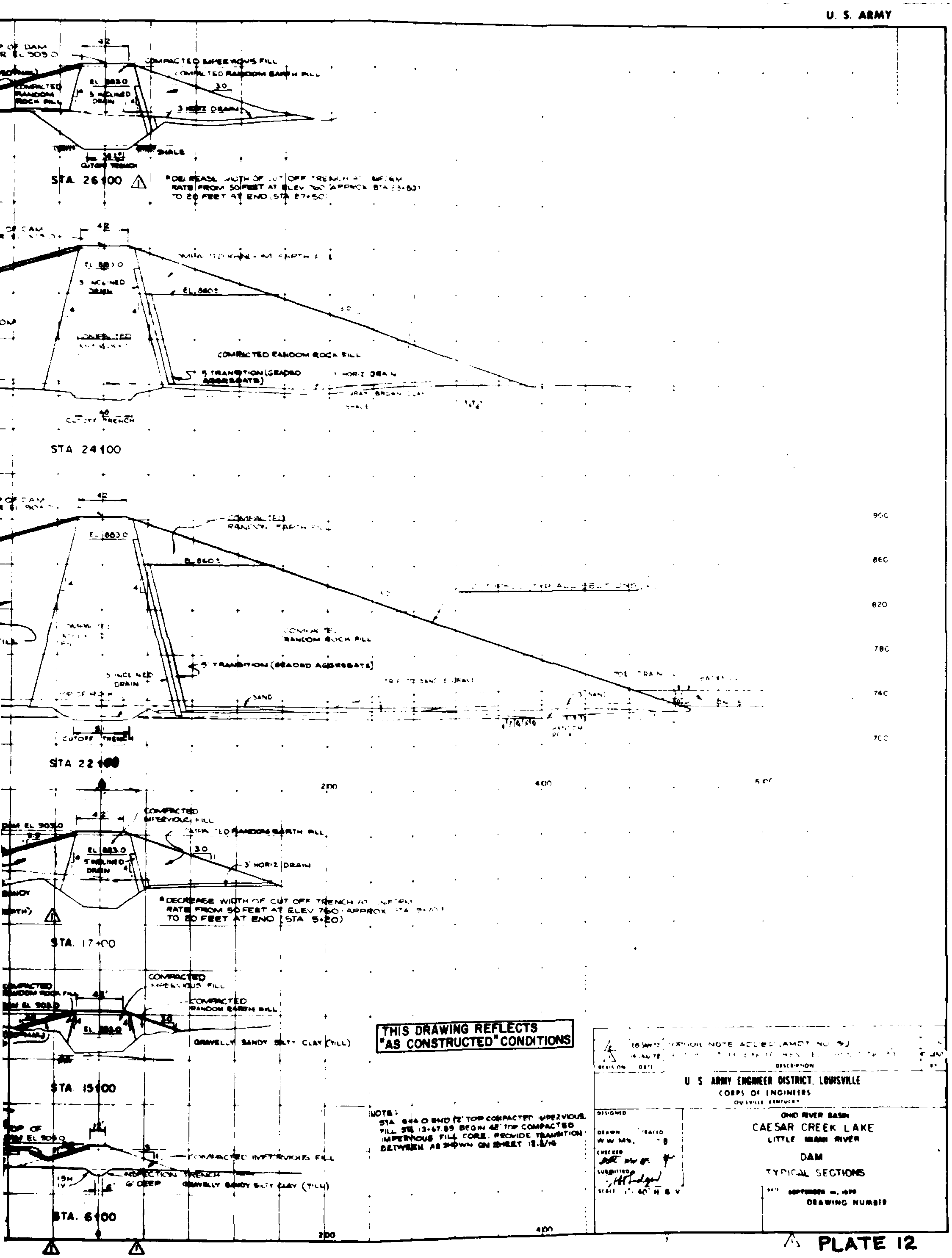
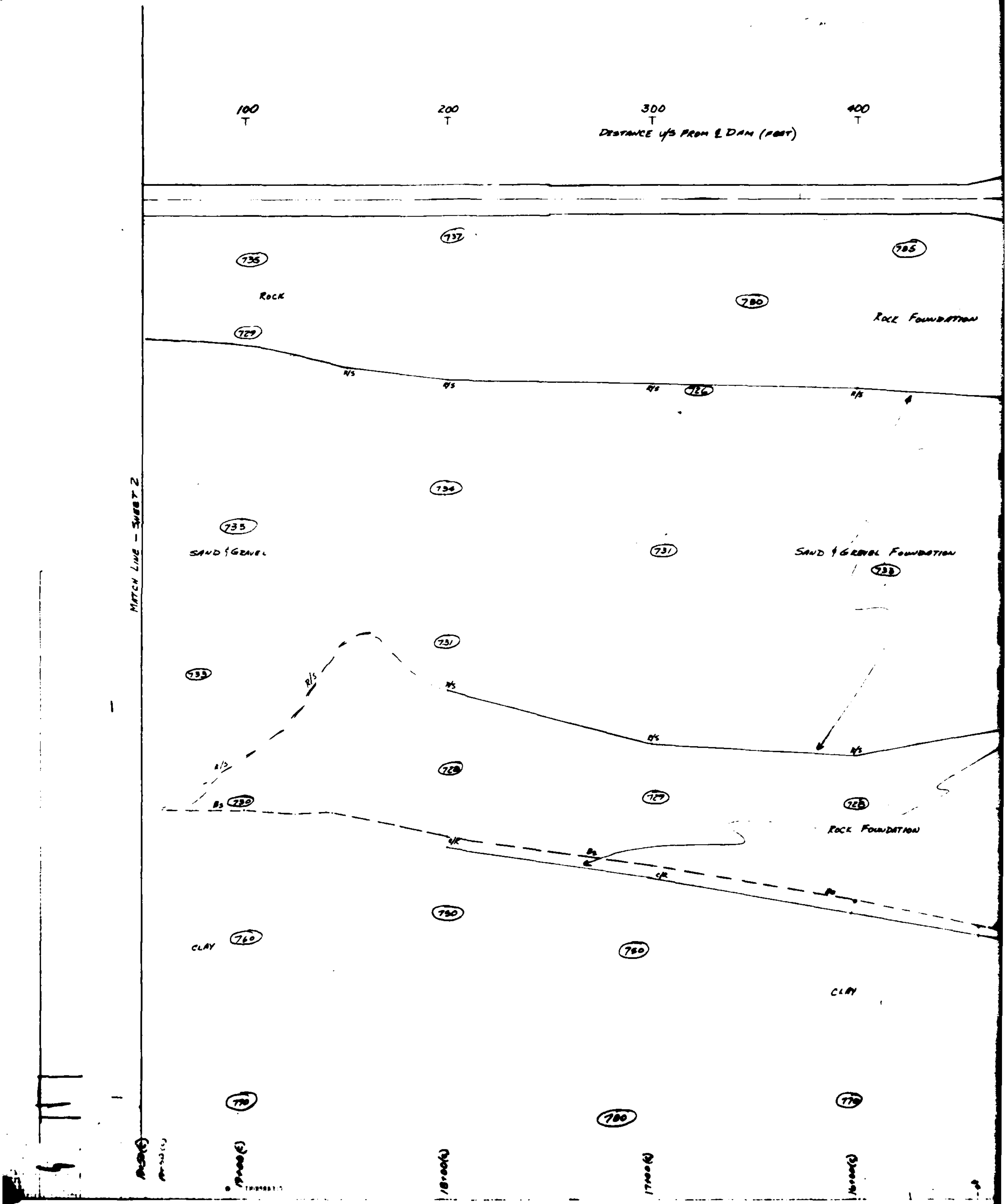

U. S. ARMY
ACCESS ROAD
FUTURE PARKING AREA
FUTURE OFFICE & SHOP SITE
TOWER ROAD SEE SH 36
PARKING AREA
FUTURE RESIDENCES
PARKING AREA SEE SH 39
OVERLOOK ROAD SEE SH 39
STONE DRAIN SEE SH 2
SERVICE BRIDGE
CONTROL TOWER
INLET CHANNEL SEE SH 12
CAESAR CREEK
TRASH BOOM SEE SH 7
WASTE AND STORAGE AREA (FLOW FROM FLAT ROCK CREEK SHALL NOT BE BLOCKED)
RIPRAP
NOTE STONE DRAIN FROM EL 900.0 TO EL 895.0
NOTE CONSTRUCTION OF RIGHT ABUTMENT ACCESS ROAD BETWEEN STA 35+00 & STA 95+32 OVERLOOK ROAD, PARKING AREA & OVERLOOK SHALL BE COMPLETED BY 1 AUGUST 1972
PLAN
14 JAN 72 BARRICADES REV'D
OVERLOOK REV'D & CONTRACTORS WORKING LIMITS ADDED
REVISION DATE DESCRIPTION
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE KENTUCKY
DESIGNED
DRAWN C A D
TRACED J E N
CHECKED C.A.O.
SUBMITTED
SCALE 1" = 100'
CAESAR CREEK LAKE
LITTLE MIAMI RIVER
DAM
SITE PLAN
DATE
DRAWING NUMBER
LM 52-12.3/1

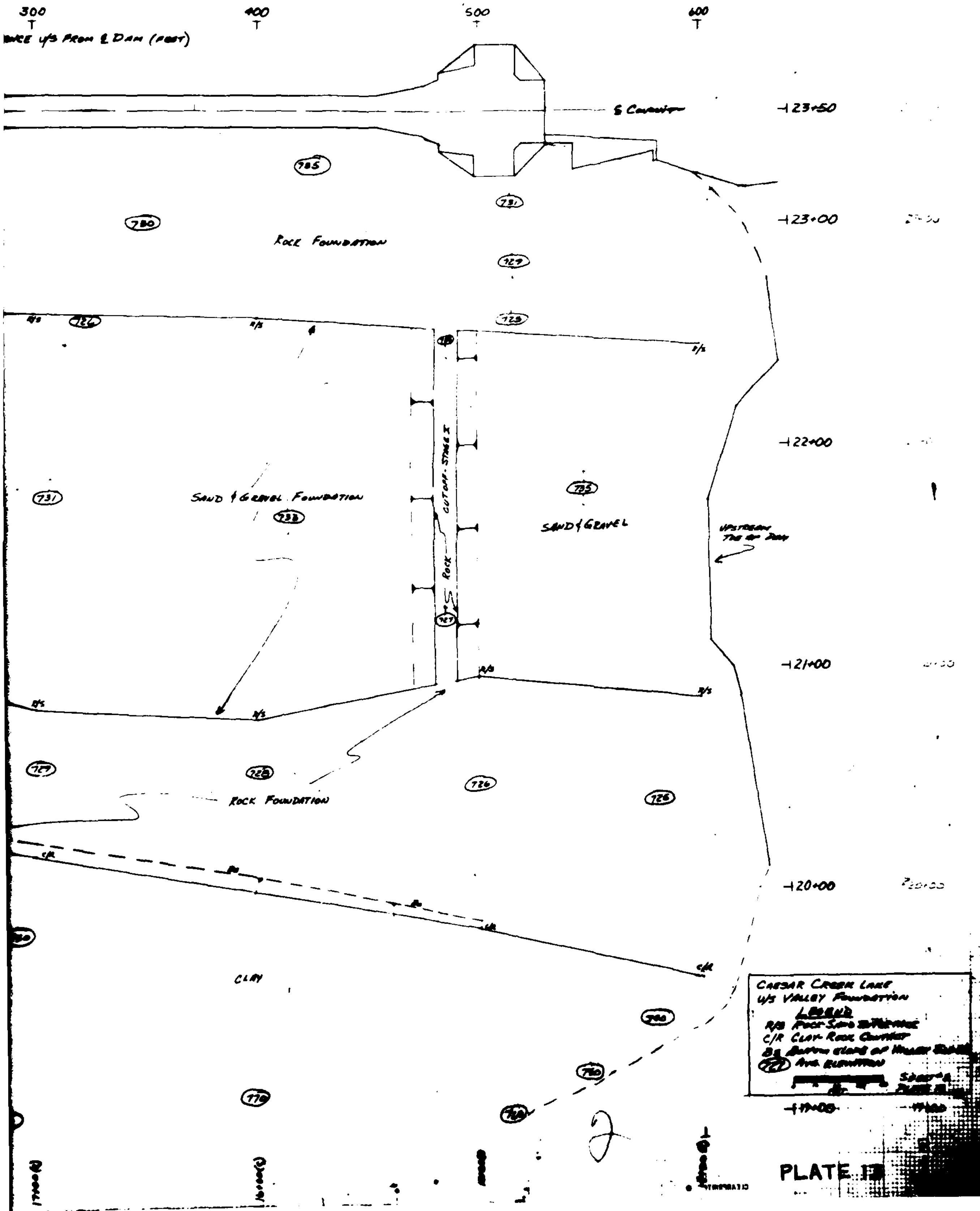
PLATE 11

CORPS OF ENGINEERS



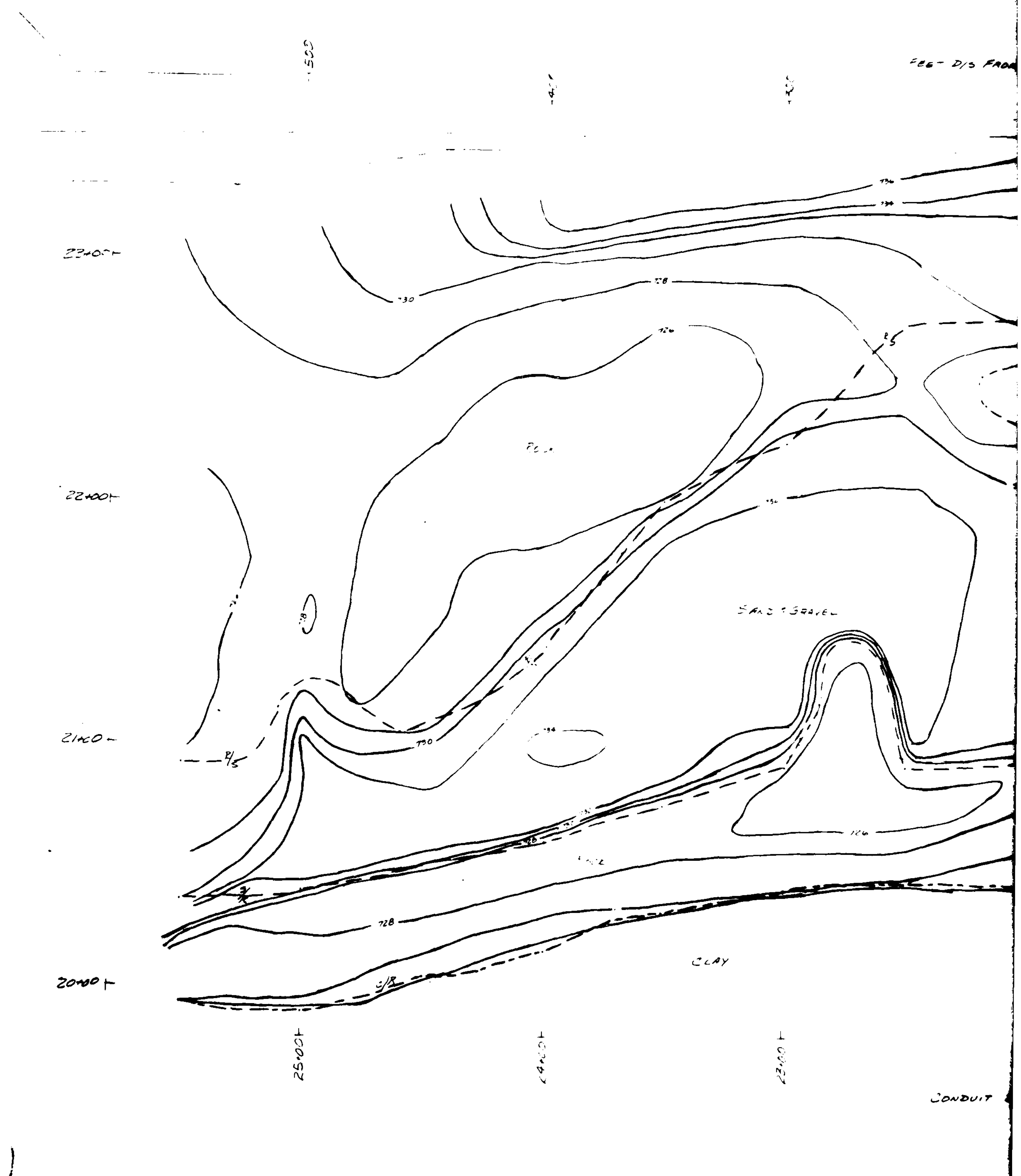

U. S. ARMY
COMPACTED IMPERVIOUS FILL
COMPACTED RANDOM EARTH FILL
COMPACTED RANDOM ROCK FILL
EL 883.0
5' INCLINED DRAIN
3' HORIZ DRAIN
CUTOFF TRENCH
SHALE
STA. 26+00
*DECREASE WIDTH OF CUTOFF TRENCH AT UNIFORM RATE FROM 50 FEET AT ELEV 760 (APPROX STA 23+60) TO 20 FEET AT END (STA 27+50)
COMPACTED RANDOM EARTH FILL
COMPACTED RANDOM ROCK FILL
5' TRANSITION (GRADED AGGREGATE)
STA 24+00
COMPACTED RANDOM EARTH FILL
EL 883.0
EL 860±
COMPACTED RANDOM ROCK FILL
5' TRANSITION (GRADED AGGREGATE)
5' INCLINED DRAIN
SAND
CUTOFF TRENCH
STA 22+00
900
860
820
780
740
700
200
400
600
COMPACTED IMPERVIOUS FILL
COMPACTED RANDOM EARTH FILL
EL 883.0
5' INCLINED DRAIN
3' HORIZ DRAIN
*DECREASE WIDTH OF CUT OFF TRENCH AT UNIFORM RATE FROM 50 FEET AT ELEV 760 (APPROX STA 9+70) TO 20 FEET AT END (STA 5+20)
STA. 17+00
COMPACTED IMPERVIOUS FILL
COMPACTED RANDOM EARTH FILL
GRAVELLY SANDY SILTY CLAY (TILL)
STA. 15+00
THIS DRAWING REFLECTS "AS CONSTRUCTED" CONDITIONS
NOTE: STA 6+40.0 END (2' TOP COMPACTED IMPERVIOUS FILL. STA 13+67.89 BEGIN 48' TOP COMPACTED IMPERVIOUS FILL CORE. PROVIDE TRANSITION BETWEEN AS SHOWN ON SHEET 12.3/16
COMPACTED IMPERVIOUS FILL
INSPECTION TRENCH 6' DEEP
GRAVELLY SANDY SILTY CLAY (TILL)
STA. 6+00
200
400
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
OHIO RIVER BASIN
CAESAR CREEK LAKE
LITTLE MIAMI RIVER
DAM
TYPICAL SECTIONS
SCALE 1" = 40' H & V
SEPTEMBER 1970
DRAWING NUMBER
PLATE 12


100
200
300
400
DISTANCE U/S FROM ℄ DAM (FEET)
ROCK
ROCK FOUNDATION
SAND & GRAVEL
SAND & GRAVEL FOUNDATION
ROCK FOUNDATION
CLAY
CLAY
MATCH LINE - SHEET 2



300
400
500
600
ANCE U/S FROM ℄ DAM (FEET)
℄ CONDUIT
23+50
23+00
22+00
21+00
20+00
785
780
731
729
728
ROCK FOUNDATION
726
731
SAND & GRAVEL FOUNDATION
733
CUTOFF - STAGE I
ROCK
727
735
SAND & GRAVEL
UPSTREAM TOE OF DAM
729
728
726
726
ROCK FOUNDATION
CLAY
780
780
770
CAESAR CREEK LAKE
U/S VALLEY FOUNDATION
LEGEND
R/S ROCK-SAND INTERFACE
C/R CLAY-ROCK CONTACT
AVG. ELEVATION


PLATE 13


FEE - D/S FROM
23+00
730
728
726
730
22+00
SAND & GRAVEL
21+00
730
734
726
728
728
20+00
CLAY
25+00
23+00
CONDUIT

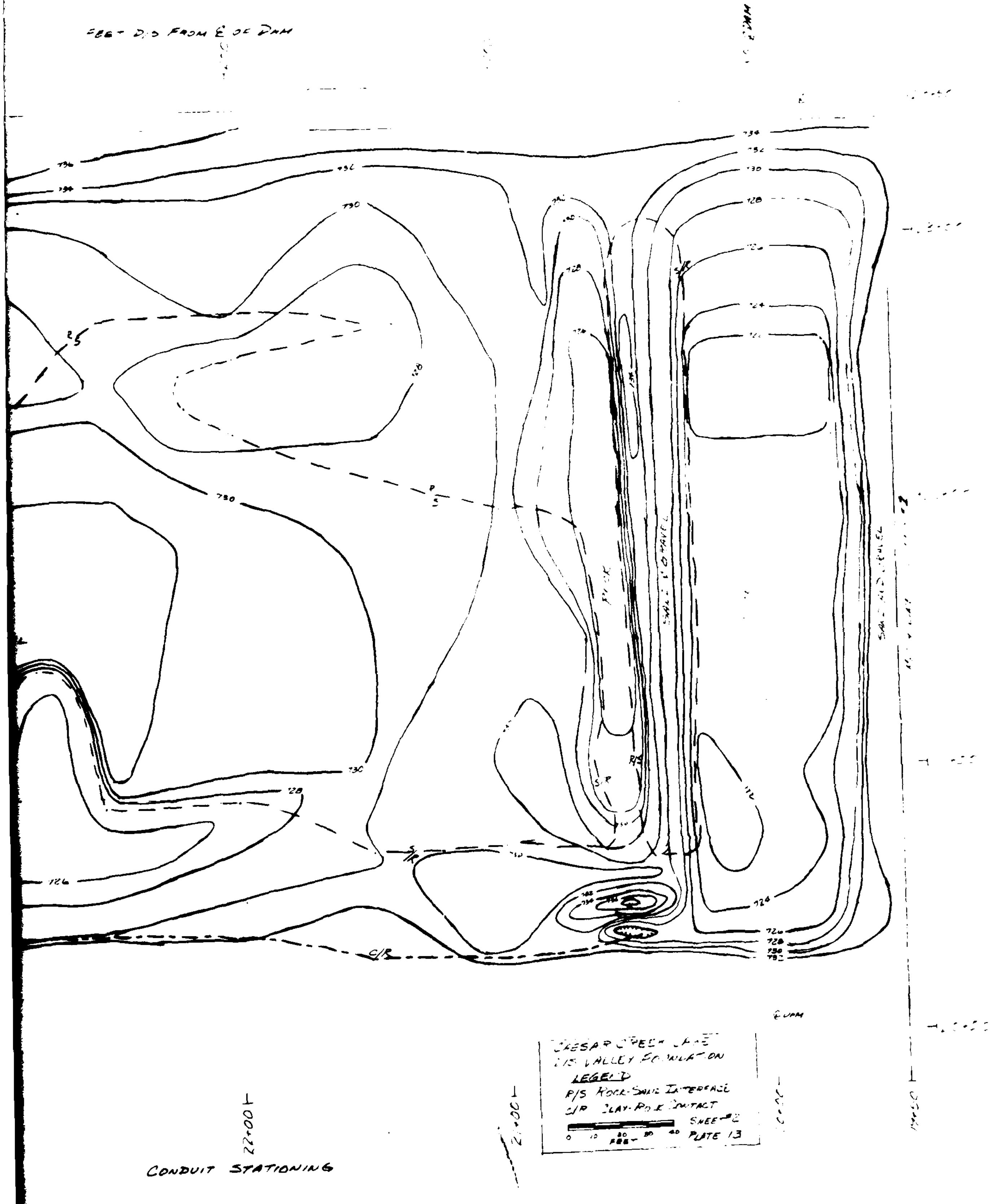
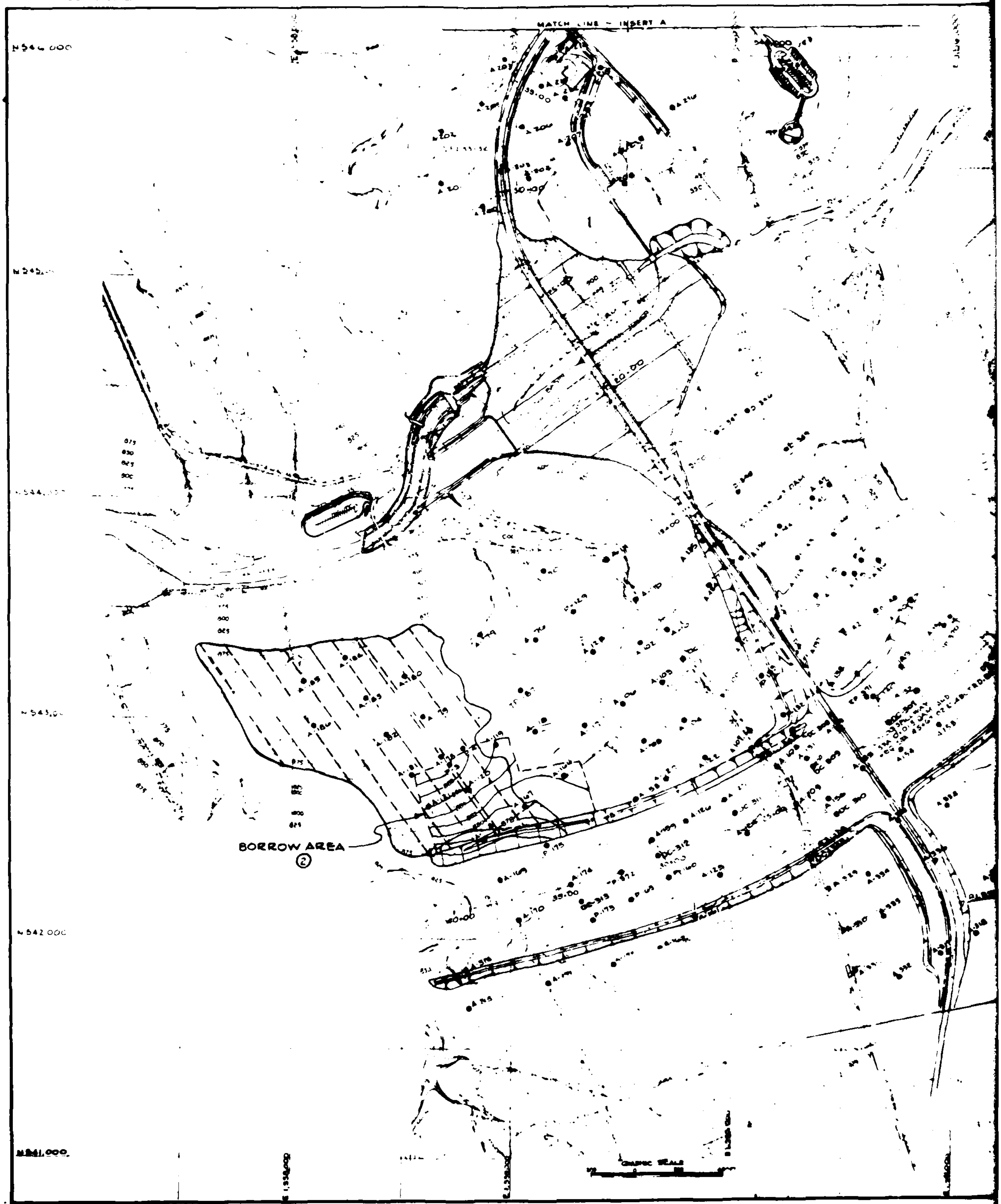

FEET D/S FROM ℄ OF DAM
CONDUIT STATIONING
22+00
LEGEND
R/S ROCK-SAND INTERFACE
C/R CLAY-ROCK CONTACT
PLATE 13
FEET
734
732
730
728
726
724
ROCK

PLATE 14

CORPS OF ENGINEERS



U.S. ARMY

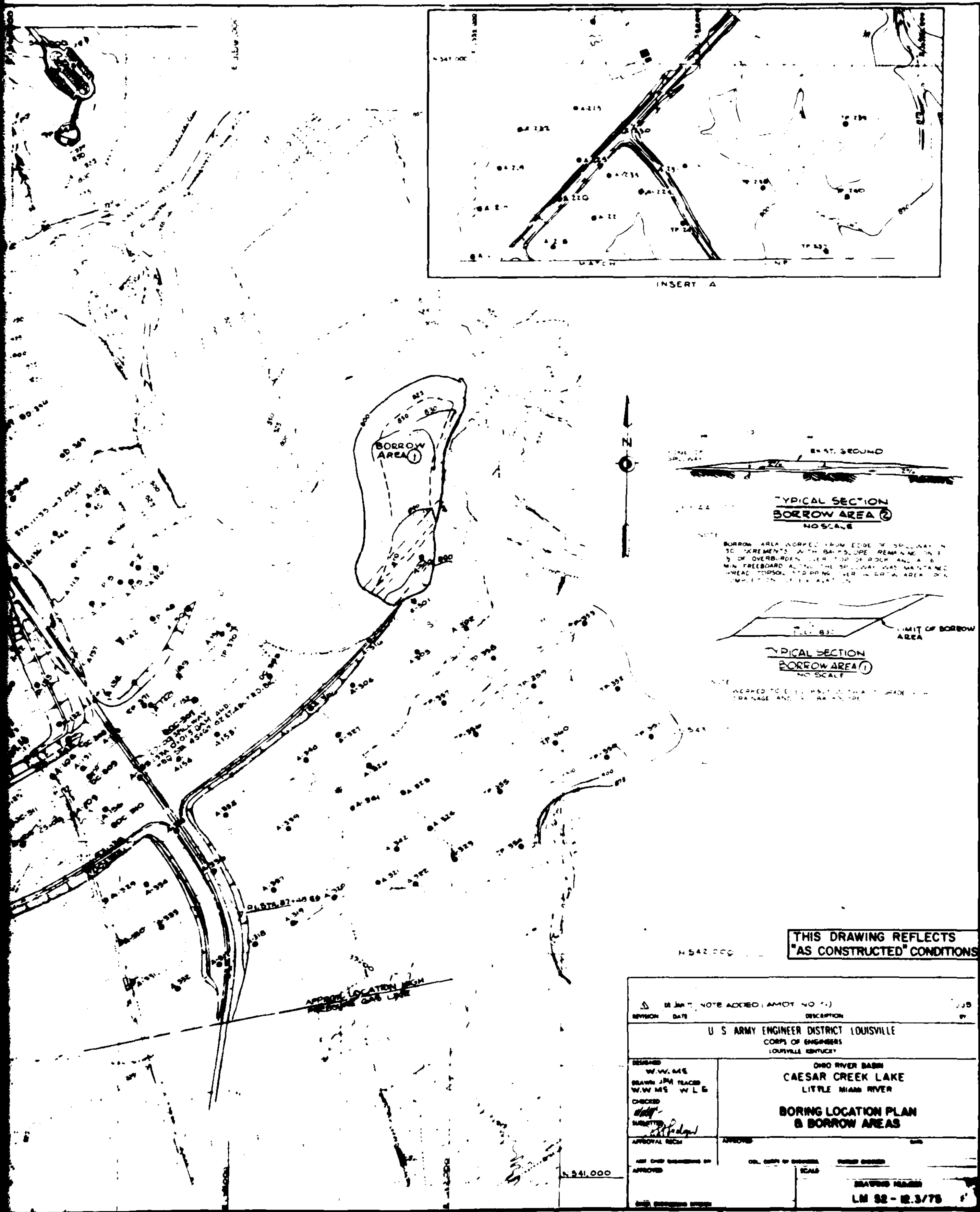
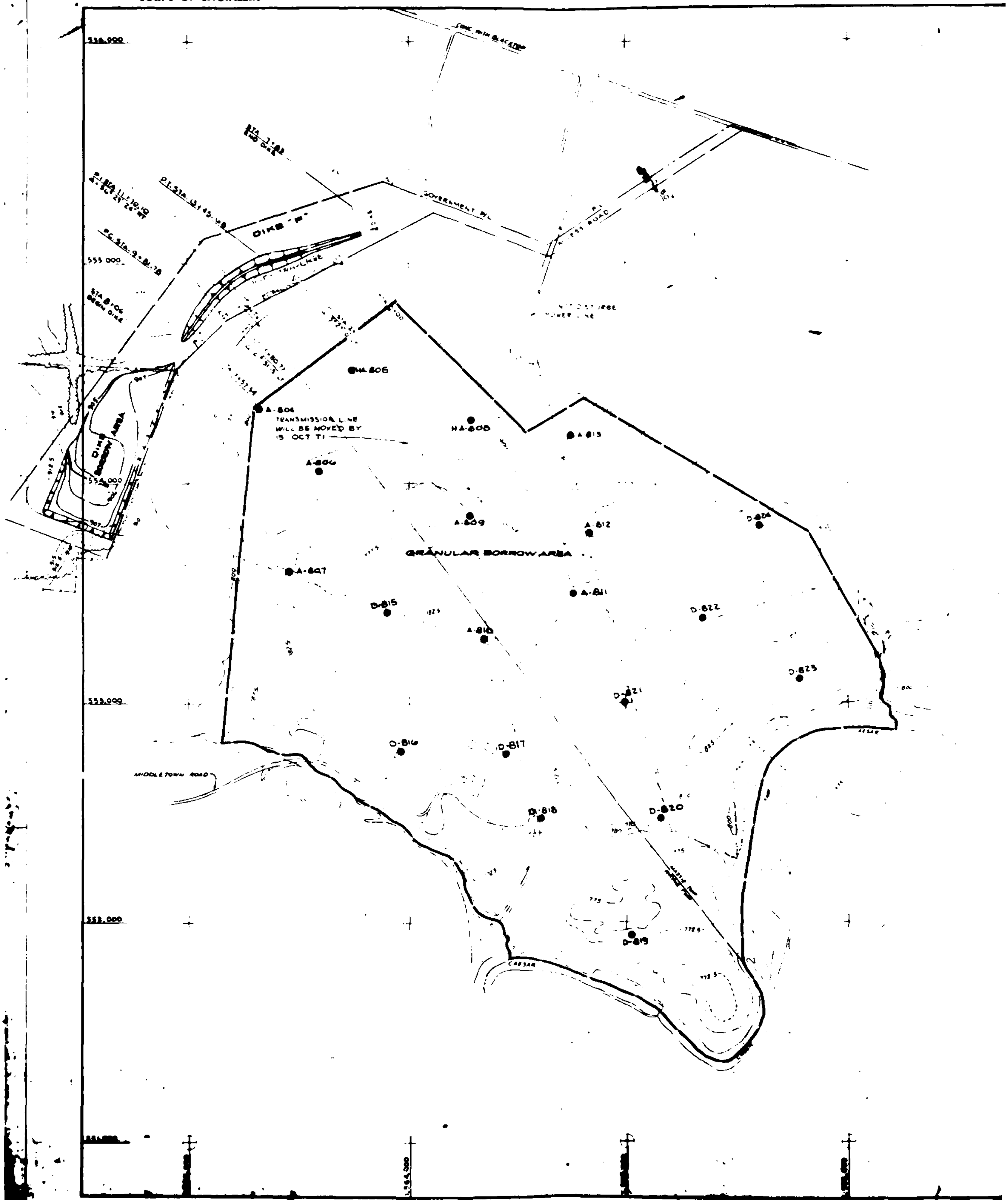



PLATE 15

2

CORPS OF ENGINEERS



U. S. ARMY


NOTES
1 EXCAVATION BELOW EL 800 SHALL BE LEFT IN CONDITION TO BE SAFE FOR PEOPLE AND ANIMALS
2 EXCAVATION BETWEEN EL 800 AND EL 849 SHALL BE GRADED TO PRESENT A NEAT APPEARANCE AND DRAIN PROPERLY, WITH FINAL SLOPE NOT STEEPER THAN FOUR HORIZONTAL TO ONE VERTICAL (4 1)
3 HAUL ROAD BETWEEN EL 849 AND ACCESS SHOWN SHALL BE LOCATED TO AVOID TREES AND SHALL BE OBLITERATED UPON COMPLETION OF USE

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | SHEET ADDED (AMDT NO 4) | E M |

U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE KENTUCKY

DESIGNED
DRAWN TRACED
CHECKED BIG DC
SUBMITTED
APPROVAL RECM
ASST CHIEF ENGINEERING DIV
APPROVED
CHIEF ENGINEERING DIVISION

OHIO RIVER BASIN
CAESAR CREEK RESERVOIR
LITTLE MIAMI RIVER
DAM
GRANULAR BORROW AREA

APPROVED DATE
COL CORPS OF ENGINEERS DISTRICT ENGINEER
SCALE
DRAWING NUMBER
LM 52-12 3/15

PLATE 16

# EXCAVATION AND BORROW

| | DAM | SPILLWAY | OUTLET WORKS | LFT. ABT. ROAD | BORROW AREA 1 |
|---|---|---|---|---|---|
| TOPSOIL | 50,000 | 73,000 | 12,000 | 8,000 | 8,000 |
| EARTH | 170,900 | 398,800 | 39,000 | 31,000 | — |
| WASTE | 30,100 | 16,000 | 12,000 | — | — |
| RANDOM ROCK | 8,000 | 1,106,500 | 99,500 | 107,000 | 132,000 |
| TOTAL | 259,000 | 1,594,300 | 162,500 | 146,000 | 140,000 |

| FILL QUANTITIES | 2,295,915 |
|---|---|
| RANDOM ROCK | 1,598,000 |
| IMPERVIOUS | 450,000 |
| RANDOM EARTH | 112,000 |
| GRANULAR BF | 7,370 |
| INC. DRAIN | 19,500 |
| HOR. DRAIN | 37,750 |
| GRADED AGG. | 13,300 |
| BEDDING | 12,780 |
| RIP-RAP | 28,400 |
| TOPSOIL | 14,680 |
| ROADWAY | 2,135 |

* TOPSOIL ALSO USED TO RECLAIM BOR

* WASTE INCLUDES MATERIAL USED IN
AND UNSUITABLE MATERIAL DISPOSE
DESIGNATED WASTE AREAS

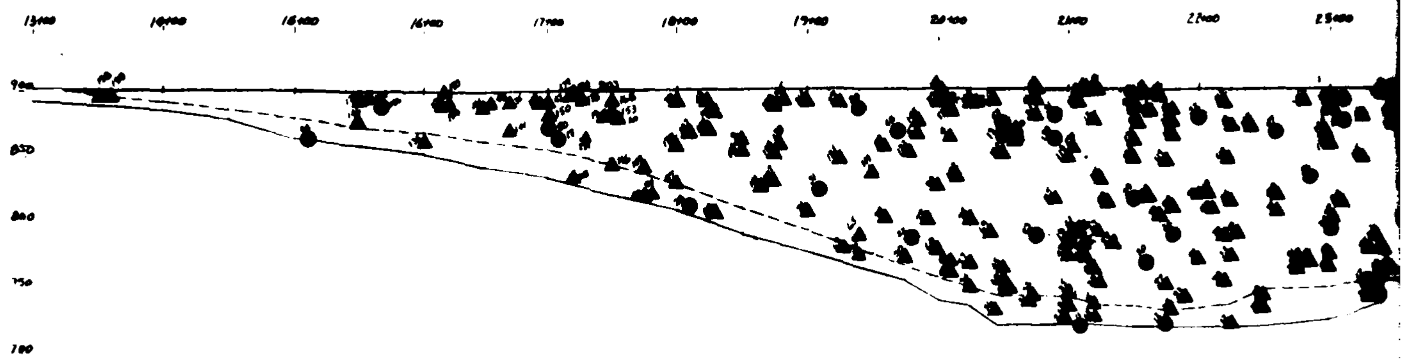
RROW

| LFT. ABT ROAD | BORROW AREA 1 | BORROW AREA 2 | TOTAL | BALANCE FACTOR | ADJUSTED TOTAL |
| --- | --- | --- | --- | --- | --- |
| 8,000 | 8,000 | 4,000 | 155,000 * | 1.00 | 155,000 |
| 31,000 | — | 30,300 | 670,000 | 0.85 | 570,000 |
| — | — | — | 58,100 * | 1.00 | 58,100 |
| 107,000 | 132,000 | — | 1,453,000 | 1.10 | 1,598,000 |
| 146,000 | 140,000 | 34,300 | | | |

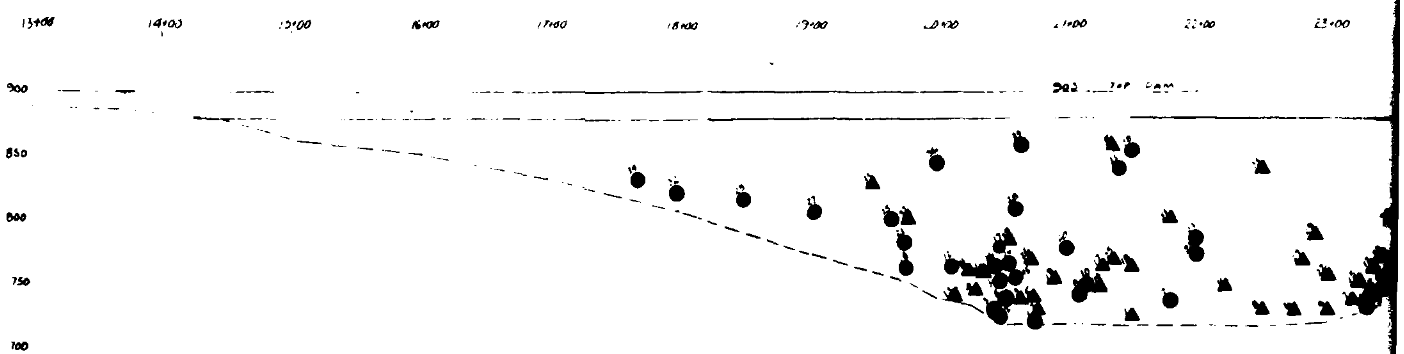
USED TO RECLAIM BORROW AREAS

DES MATERIAL USED IN HAUL ROADS
ABLE MATERIAL DISPOSED OF IN
WASTE AREAS

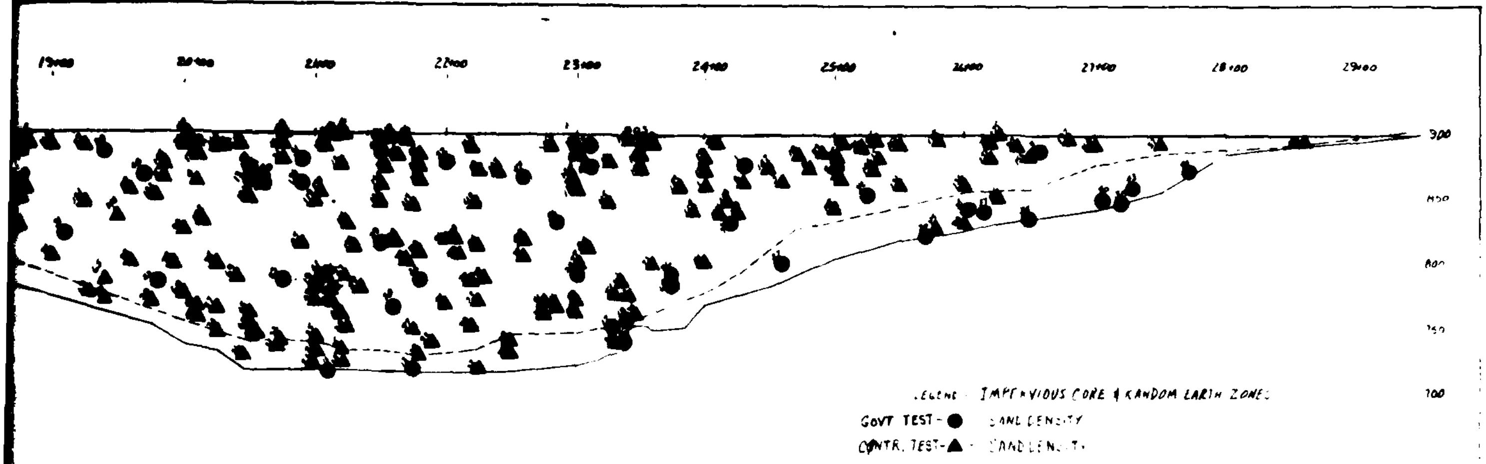
CAESAR CREEK LAKE
MATERIALS CHART
PLATE # 6

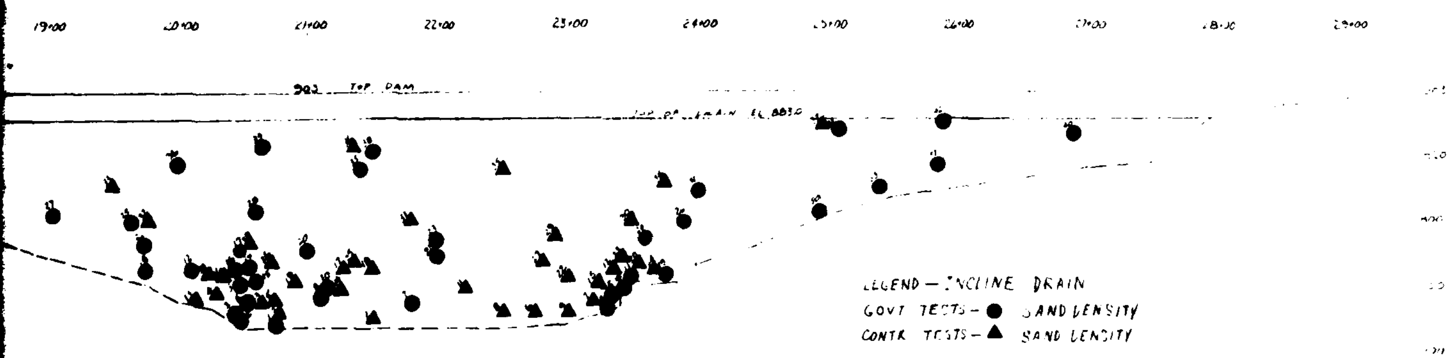


900
850
800
750
700

14+00
16+00
17+00
18+00
23+00
900
850
800
750
700




| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

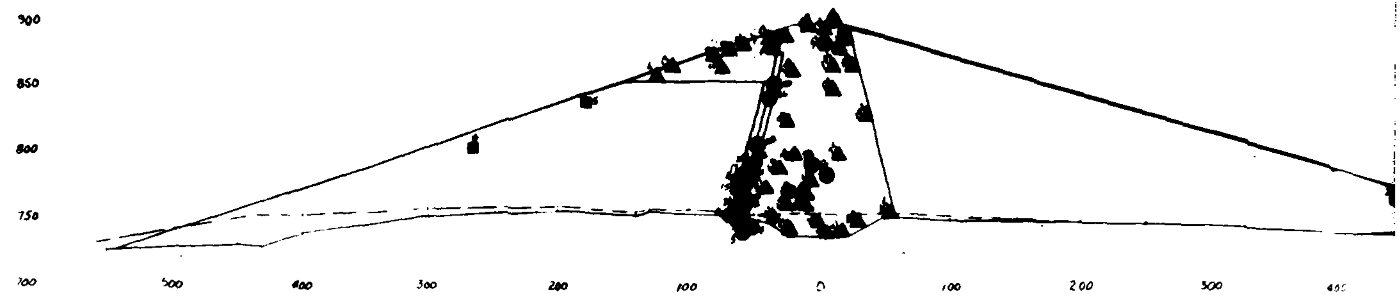
DESIGNED:
DRAWN: TRACED:
CHECKED:
SUBMITTED:

CAESAR CREEK LAKE
DENSITY TESTS
IMPERVIOUS-RANDOM EARTH
INCLINED DRAIN

SCALE
DATE
DRAWING NUMBER

2

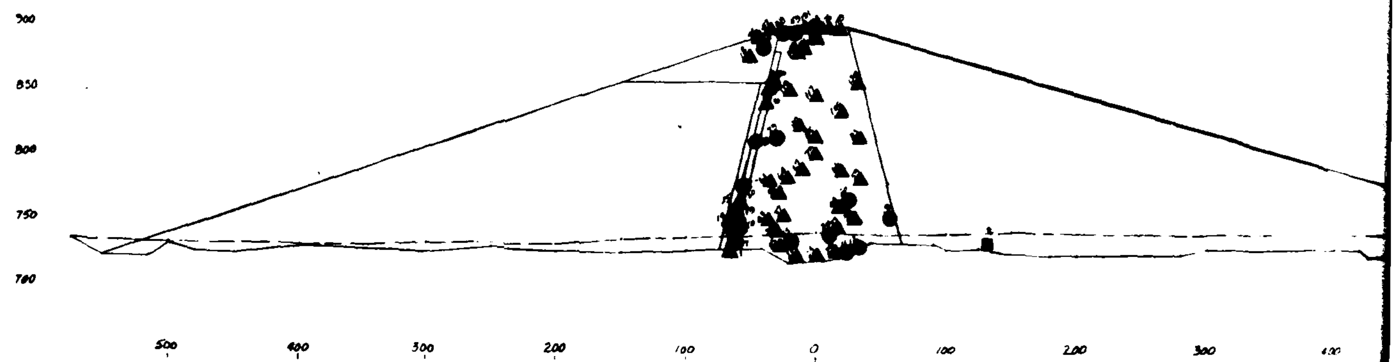
PLATE 18




20+00

SAMPLE NUMBER AT

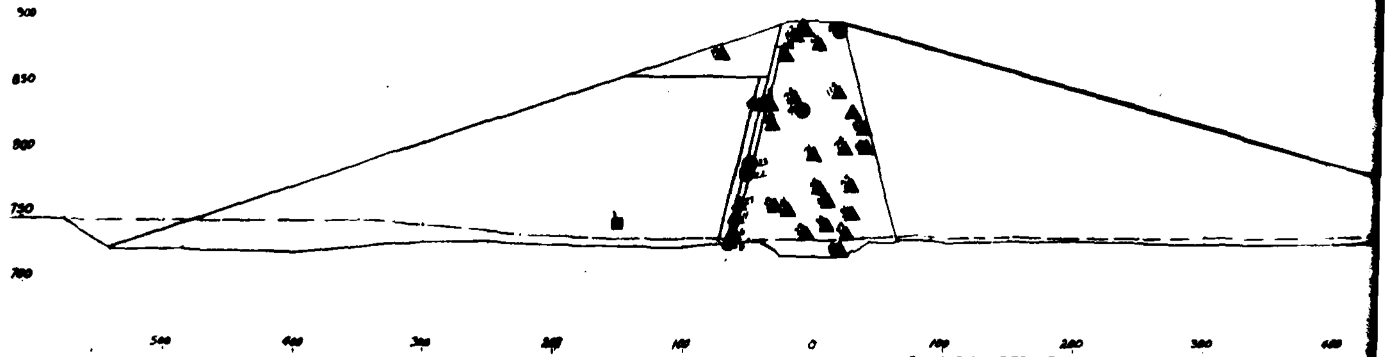
| STATION 19+75 | 20+25 | 20+50 | 20+75 |
|---|---|---|---|
| 5 | 34 | 8 | 27 |
| 22 | 44 | 9 | 23 |
| 48 | 57 | 13 | 31 |
| 50 | 75 | 26 | 32 |
| 122 | 160 | 40 | 46 |
| 145 | 13 | 42 | 51 |
| 18 | 21 | 45 | 159 |
| 21 | | 69 | 190 |
| 32 | | 2, 9/10 | 2, 120 |
| | | 5, 16/14 | 35 |
| | | 13, 16/17 | |
| | | 20 | |




21+00

SAMPLE NUMBER AT

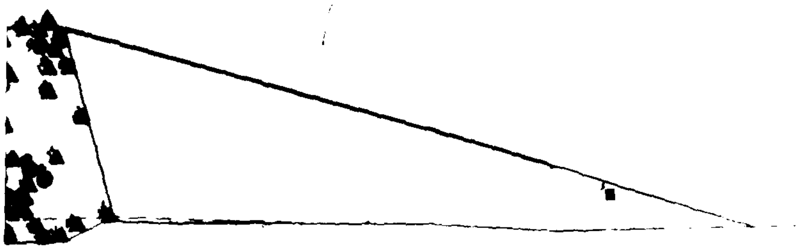
| STATION 21+25 | 21+50 | 21+75 |
|---|---|---|
| 11 | 6 | 12 |
| 15 | 20 | 24 |
| 12 | 29 | 26 |
| 23 | 48 | 28 |
| 38 | 49 | 35 |
| 44 | 59 | 37 |
| 55 | 83 | 47 |
| 64 | 90 | 79 |
| 106 | 67 | 83 |
| 176 | 185 | 117 |
| 189 | 191 | 189 |
| 192 | 1 | 186 |
| 10 | 18 | 1 |
| 14 | 35 | 81 |
| 23 | 36 | |
| | 38 | |




22+00

SAMPLE NUMBER AT

| STATION 22+25 | 22+50 | 22+75 |
|---|---|---|
| 22 | 21 | 56 |
| 35 | 29 | 61 |
| 53 | 71 | 66 |
| 14 | [illegible] | 36 |
| 78 | [illegible] | 163 |
| 113 | [illegible] | 6 |
| 162 | 198 | 17 |
| 11 | 9 | |
| | 33 | |

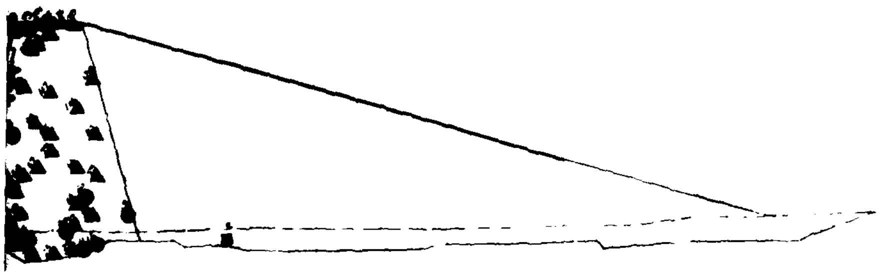


0 100 200 300 400 500 600

20+00

SAMPLE NUMBER AT STATION

| 19+75 | 20+25 | 20+50 | 20+75 |
|---|---|---|---|
| [illegible] | 34 | 8 | 27 |
| 22 | 44 | 9 | 23 |
| 48 | 57 | 15 | 31 |
| 50 | 75 | 26 | 32 |
| 122 | 160 | 40 | 46 |
| 145 | 13 | 42 | 51 |
| 18 | 21 | 45 | 139 |
| 21 | | 69 | 130 |
| 52 | | 2, 8/0 | 2, 120 |
| | | 5, 10/4 | 35 |
| | | 15, 10/7 | |
| | | 28 | |



0 100 200 300 400 500 600

21+00

SAMPLE NUMBER AT STATION

| 21+25 | 21+50 | 21+75 |
|---|---|---|
| 11 | 4 | 12 |
| 15 | 20 | 24 |
| 12 | 28 | 26 |
| 23 | 48 | 28 |
| 38 | 49 | 33 |
| 44 | 59 | 37 |
| 55 | 85 | 47 |
| 64 | 90 | 79 |
| 106 | 67 | 83 |
| 176 | 185 | 117 |
| 185 | 191 | 149 |
| 192 | 1 | 186 |
| 10 | 18 | 7 |
| 14 | 35 | 31 |
| 25 | 36 | |
| | 38 | |

0 100 200 300 400 500 600

22+00

SAMPLE NUMBER AT STATION

| 22+25 | 22+50 | 22+75 |
|---|---|---|
| 22 | 23 | 26 |
| 39 | 29 | 41 |
| 53 | 71 | 46 |
| 14 | [illegible] | 56 |
| 78 | [illegible] | 163 |
| 113 | [illegible] | 6 |
| 162 | 190 | 67 |
| 11 | 6 | |
| | 33 | |

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

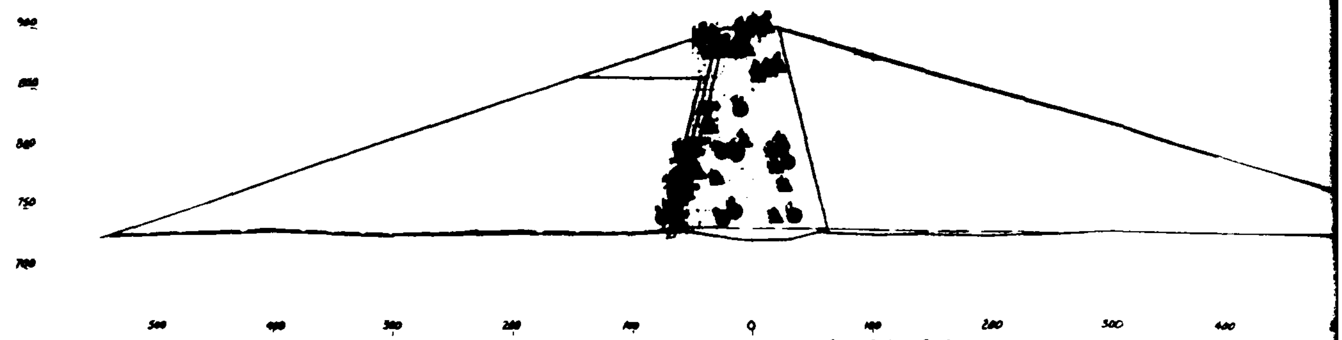
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

DESIGNED | DRAWN | TRACED | CHECKED | SUBMITTED | SCALE | DATE

CAESAR CREEK LAKE
DENSITY TESTS
STA 20+00 - 22+75

DRAWING NUMBER
PLATE 9

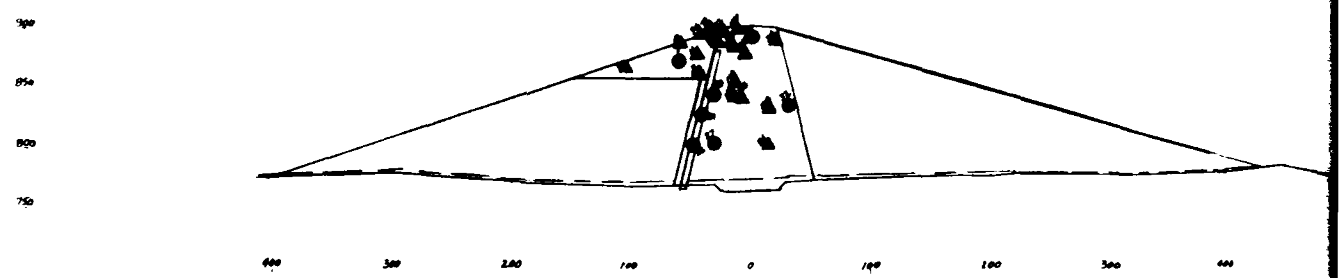
PLATE 19




23+00

SAMPLE NUMBER AT STATION

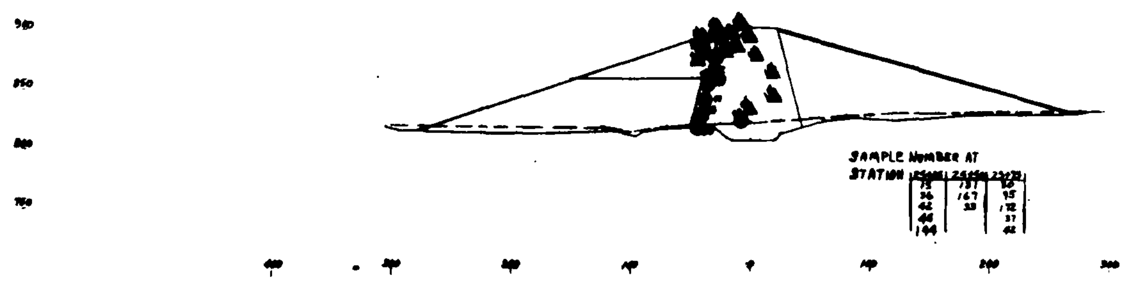
| 23+25 | 23+50 | 23+75 |
|---|---|---|
| 16 | [illegible] | 26 |
| 17 | 21 | 68 |
| 18 | 28 | 153 |
| 30 | 38 | 29 |
| 31 | 73 | 34 |
| 62 | 148 | |
| 4 | 150 | |
| 6 | 183 | |
| 7 | 9 | |
| | 12 | |
| | 15 | |
| | 23 | |
| | 11 | |
| | 20 | |
| | 30 | |
| | 34 | |




24+00

SAMPLE NUMBER AT STATION

| 24+25 | 24+50 | 24+75 |
|---|---|---|
| 32 | 1 | 11 |
| 34 | 3 | 18 |
| 1(.) | 6 | 51 |
| 118 | 27 | 54 |
| | 28 | |
| | 39 | |
| | 147 | |
| | 177 | |




SAMPLE NUMBER AT STATION

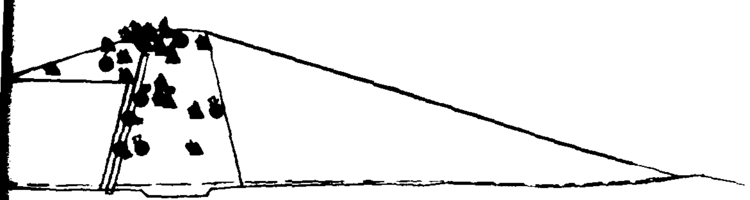
| [illegible] | 25+50 | [illegible] |
|---|---|---|
| 75 | 151 | 36 |
| 36 | 167 | 95 |
| 42 | 33 | 172 |
| 46 | | 37 |
| 144 | | 42 |

25+00

23+00

SAMPLE NUMBER AT STATION

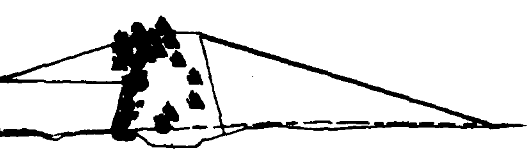
| 23+25 | 23+50 | 23+75 |
| --- | --- | --- |
| 16 | [illegible] | 26 |
| 17 | 81 | 68 |
| 18 | [illegible] | 158 |
| 30 | 58 | 29 |
| 31 | 73 | 34 |
| 62 | 168 | |
| 4 | 158 | |
| [illegible] | 183 | |
| 7 | 9 | |
| | 12 | |
| | 15 | |
| | 23 | |
| | 11 | |
| | 20 | |
| | 30 | |
| | 34 | |



24+00

SAMPLE NUMBER AT STATION

| 24+25 | 24+50 | 24+75 |
| --- | --- | --- |
| 32 | 1 | 11 |
| 34 | 3 | 18 |
| 108 | 6 | 31 |
| 118 | 27 | 34 |
| | 26 | |
| | 39 | |
| | 147 | |
| | 177 | |



SAMPLE NUMBER AT STATION

| [illegible] | 25+50 | 25+75 |
| --- | --- | --- |
| 75 | 151 | 34 |
| 36 | 167 | 95 |
| 42 | 38 | 172 |
| 46 | | 37 |
| 144 | | 62 |

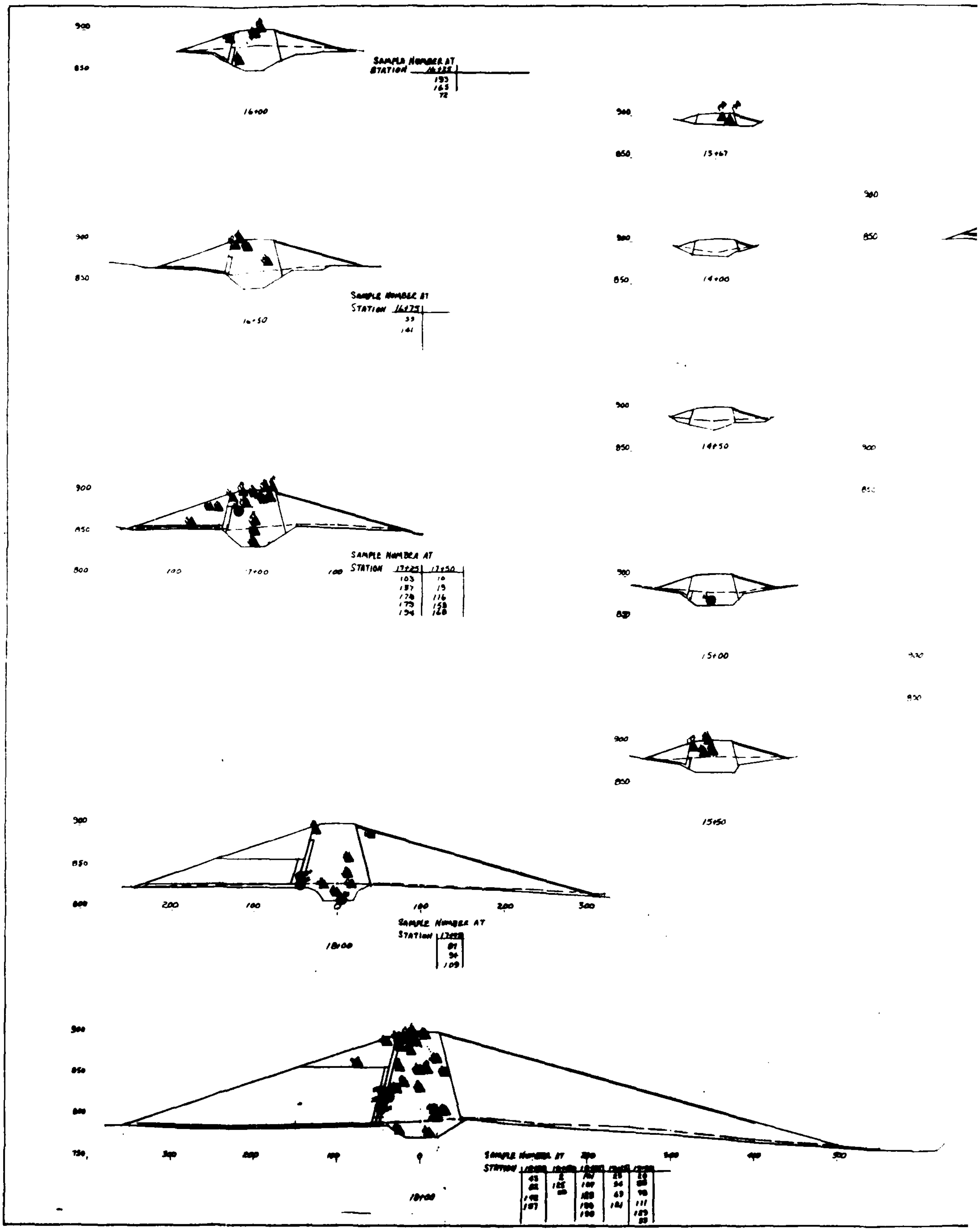
25+00

U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

CAESAR CREEK LAKE
DENSITY TESTS
STA 23+00 – 25+75

PLATE 10

PLATE 20



16+00
SAMPLE NUMBER AT STATION 16+25
193
163
72
15+67
16+50
SAMPLE NUMBER AT STATION 16+75
55
141
14+00
14+50
17+00
SAMPLE NUMBER AT STATION 17+25 17+50
103 10
157 19
178 116
175 158
194 160
15+00
15+50
18+00
SAMPLE NUMBER AT STATION
81
94
109
19+00
SAMPLE NUMBER AT STATION

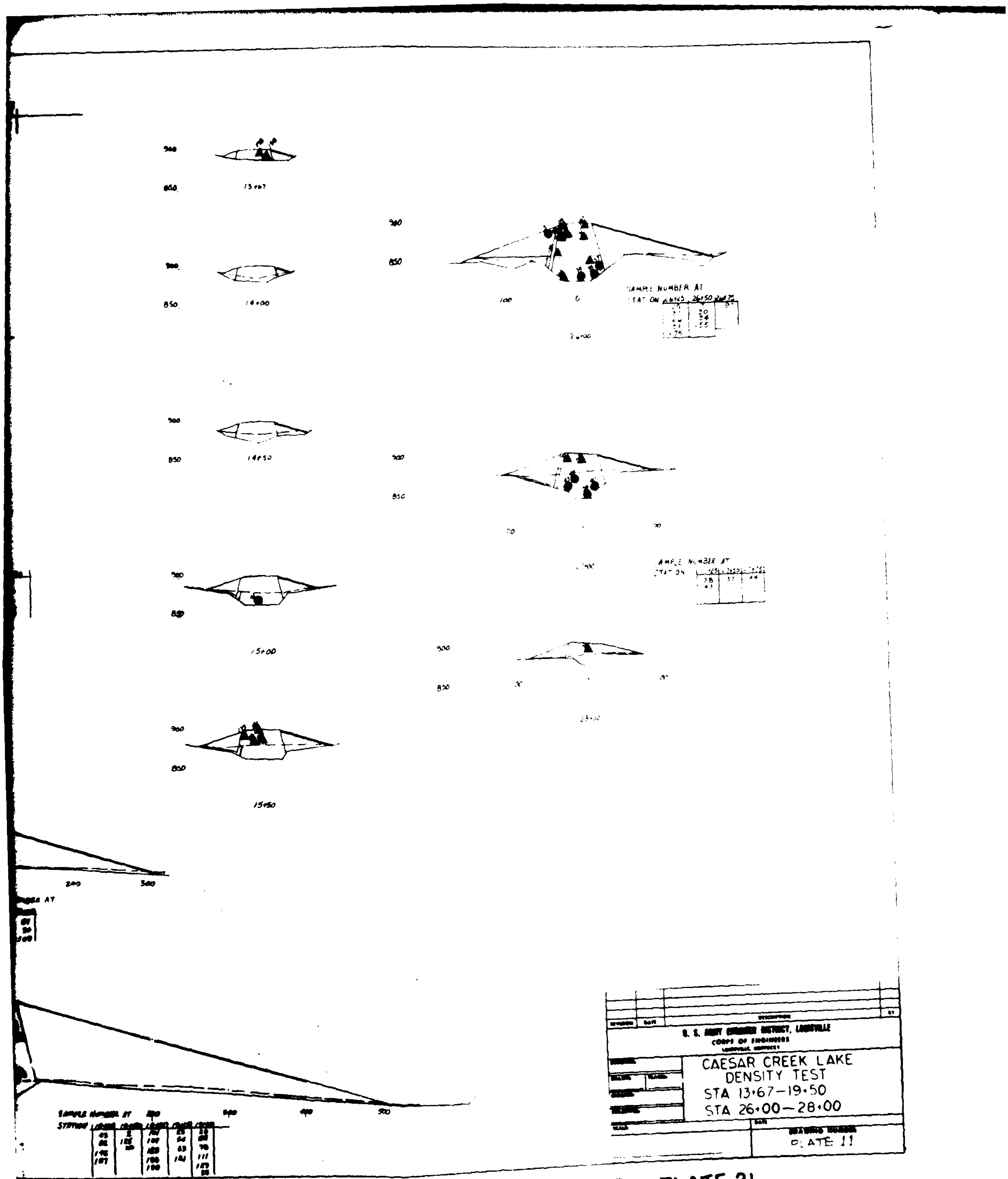

13+67
14+00
14+50
15+00
15+50
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
CAESAR CREEK LAKE
DENSITY TEST
STA 13+67—19+50
STA 26+00—28+00
PLATE 11

**PLATE 21**

CONTRACTOR FIELD C

| MATERIAL (ZONE) | NUMBER OF TESTS | DRY DENSITY | | | | PERCENT COMP | | |
|---|---|---|---|---|---|---|---|---|
| | | HIGH | LOW | AVERAGE | DESIGN | HIGH | LOW | AVERAG |
| IMPERVIOUS | 199 * | 128.5 | 90.3 | 108.6 | 105.6 | 111.3 | 92.4 | 101.6 |
| RANDOM | 11 ** | 133.1 | 93.7 | 110.3 | 108.7 | 108.7 | 87.9 | 98.5 |
| PERVIOUS | 37 *** | 126.3 | 106.2 | 116.9 | 100.0 | 100.0 | 79.0 | 81.3 |

* OF THE 199 TESTS RUN ON THE IMPERVIOUS MATERIAL 73 TESTS FAILE TESTS INDICATED THE MATERIAL WAS TOO DRY OF OPTIMUM, 4 TESTS AND 3 TESTS INDICATED THE MATERIAL WAS BOTH TOO WET OF OPTIM THAT FAILED WERE REWORKED. THERE WERE 6 AREAS THAT WERE

THE 11 TESTS RUN ON THE RANDOM MATERIALS 3 TESTS FAILED TEST INDICATED THE MATERIAL WAS BOTH TOO WET OF OPTIMUM HAT FAILED WERE REWORKED; HOWEVER, NONE OF THE AREAS

*** OF THE 37 TESTS RUN ON THE PERVIOUS MATERIAL 22 TESTS F THE COMPACTION DESIRED). 10 OF THE TEST SECTIONS THAT FAIL AND ALL THESE TESTS WERE ACCEPTABLE.

CORPS OF ENGINEERS

| MATERIAL (ZONE) | NUMBER OF TESTS | DRY DENSITY | | | | PERCENT COMP | | |
|---|---|---|---|---|---|---|---|---|
| | | HIGH | LOW | AVERAGE | DESIGN | HIGH | LOW | AVERAG |
| IMPERVIOUS | 55 * | 130.3 | 98.1 | 110.2 | 105.6 | 108.9 | 95.4 | 102.4 |
| RANDOM | 5 ** | 120.0 | 107.4 | 117.9 | 108.7 | 105.0 | 100.0 | 102.9 |
| PERVIOUS | 42 *** | 126.8 | 111.5 | 118.4 | 100.0 | 100.0 | 78.0 | 85.2 |

* OF THE 55 TESTS RUN ON THE IMPERVIOUS MATERIAL 2 TESTS FAIL BOTH OF THE TEST SECTIONS THAT FAILED WERE REWORKED. BOTH

** OF THE 5 TESTS RUN ON THE RANDOM MATERIALS 0 TESTS FA

*** OF THE 42 TESTS RUN ON THE PERVIOUS MATERIAL 11 TESTS FA THE COMPACTION DESIRED). ALL OF THE TEST SECTIONS THAT THE TESTS WERE ACCEPTABLE.

ELD COMPACTION CONTROL - DAM

| COMPACTION (1)(3) | | WATER CONTENT (3) | | | | DEVIATION FROM OPTIMUM (3) | | | |
|---|---|---|---|---|---|---|---|---|---|
| VERAGE | DESIGN | HIGH | LOW | AVERAGE | DESIGN | HIGH | LOW | AVERAGE | SPECIFIED |
| 01.6 | 95.0 | 25.2 | 11.4 | 18.1 | 20.2 | +2.4 | -2.7 | -.06 | -1.0 +1.0 |
| 98.5 | 95.0 | 24.3 | 12.1 | 15.4 | 20.2 | +1.3 | -1.0 | -.13 | -1.0 +1.0 |
| 81.3 | 80.0 | N/A (2) | N/A (3) | N/A (2) | N/A (2) | N/A (2) | N/A (2) | N/A (2) | N/A (2) N/A |

FAILED (34 TESTS INDICATED THE MATERIAL WAS TOO WET OF OPTIMUM, 32 ESTS INDICATED THE MATERIAL WAS BELOW THE COMPACTION DESIRED OPTIMUM AND BELOW THE COMPACTION DESIRED). ALL OF THE TEST SECTIONS VERE RETESTED AND ALL THESE TESTS WERE ACCEPTABLE.

ILED ( 2 TESTS INDICATED THE MATERIAL WAS TOO WET OF OPTIMUM AND MUM AND BELOW THE COMPACTION DESIRED). ALL OF THE TEST SECTIONS REAS WERE RETESTED.

TS FAILED ( ALL OF THE TESTS INDICATED THE MATERIAL WAS BELOW FAILED WERE REWORKED. THERE WERE 7 AREAS THAT WERE RETESTED

ERS ACCEPTANCE TESTS - DAM

| COMPACTION (1)(3) | | WATER CONTENT (3) | | | | DEVIATION FROM OPTIMUM (3) | | | |
|---|---|---|---|---|---|---|---|---|---|
| ERAGE | DESIGN | HIGH | LOW | AVERAGE | DESIGN | HIGH | LOW | AVERAGE | SPECIFIED |
| 02.4 | 95.0 | 24.3 | 11.0 | 17.9 | 20.2 | +1.5 | -1.0 | -.25 | -1.0 +1.0 |
| 02.9 | 95.0 | 17.7 | 13.5 | 15.4 | 20.2 | +1.0 | -0.7 | +.52 | -1.0 +1.0 |
| 85.2 | 80.0 | N/A (2) | N/A (2) | N/A (2) | N/A (2) | N/A (2) | N/A (2) | N/A (2) | N/A (2) N/A |

FAILED ( 2 TESTS INDICATED THE MATERIAL WAS TOO WET OF OPTIMUM). BOTH AREAS WERE RETESTED AND THE TESTS WERE ACCEPTABLE.

FAILED.

S FAILED (ALL OF THE TESTS INDICATED THE MATERIAL WAS BELOW HAT FAILED WERE REWORKED. ALL AREAS WERE RETESTED AND

7

PLATE 22

CONTRACTOR FIELD COM

| MATERIAL (ZONE) | NUMBER OF TESTS | DRY DENSITY | | | | PERCENT COMPAC | | |
|---|---|---|---|---|---|---|---|---|
| | | HIGH | LOW | AVERAGE | DESIGN | HIGH | LOW | AVERAGE |
| IMPERVIOUS AND RANDOM | 581 * | 149.7 | 96.2 | 118.4 | 105.6 | 110.7 | 91.4 | 100.6 |
| PERVIOUS | 16 ** | 121.0 | 107.9 | 112.9 | 109.0 | 100.1 | 78.0 | 98.8 |

* OF THE 581 TESTS RUN ON THE IMPERVIOUS AND RANDOM MAT
WAS TOO WET OF OPTIMUM, 2 TESTS INDICATED THE MATERIAL W
WAS BELOW THE COMPACTION DESIRED AND 4 TESTS INDICATE
BELOW THE COMPACTION DESIRED). ALL OF THE TEST SECTIONS
THAT WERE RETESTED AND ALL THESE TESTS WERE ACCEPTAB

** OF THE 16 TESTS RUN ON THE PERVIOUS MATERIAL 4 TESTS FA
THE COMPACTION DESIRED). ALL OF THE TEST SECTIONS THAT
THE TESTS WERE ACCEPTABLE.

CORPS OF ENGINEERS ACC

| MATERIAL (ZONE) | NUMBER OF TESTS | DRY DENSITY | | | | PERCENT COMPAC | | |
|---|---|---|---|---|---|---|---|---|
| | | HIGH | LOW | AVERAGE | DESIGN | HIGH | LOW | AVERAGE |
| IMPERVIOUS AND RANDOM | 34 * | 129.0 | 98.8 | 112.3 | 105.6 | 102.4 | 95.0 | 97.8 |
| PERVIOUS | 18 ** | 126.0 | 108.1 | 113.1 | 109.0 | 100.0 | 84.0 | 95.1 |

* OF THE 34 TESTS RUN ON THE IMPERVIOUS AND RANDOM MATERIAL

** OF THE 18 TESTS RUN ON THE PERVIOUS MATERIAL 0 TESTS FAI

1. STANDARD PROCTOR TEST USED ON THE IMPERVIOUS AND RANDOM MA
2. NOT APPLICABLE - NO MOISTURE CONTROL SPECIFIED
3. INDICATE RESULTS OF ALL TESTS FOR HIGH AND LOW VALUES AND IN

COMPACTION CONTROL - DIKES

| MPACTION ① ③ | | WATER CONTENT ③ | | | | DEVIATION FROM OPTIMUM ③ | | | |
|---|---|---|---|---|---|---|---|---|---|
| ERAGE | DESIGN | HIGH | LOW | AVERAGE | DESIGN | HIGH | LOW | AVERAGE | SPECIFIED |
| 0.6 | 95.0 | 24.0 | 4.5 | 13.1 | 20.2 | +2.2 | -2.3 | -.03 | -2.0 +2.0 |
| 8.8 | 80.0 | N/A ② | N/A ② | N/A ② | N/A ② | N/A ② | N/A ② | N/A ② | N/A ② N/A |

MATERIAL 22 TESTS FAILED (12 TESTS INDICATED THE MATERIAL
AL WAS TOO DRY OF OPTIMUM, 4 TESTS INDICATED THE MATERIAL
CATED THE MATERIAL WAS BOTH TOO WET OF OPTIMUM AND
TIONS THAT FAILED WERE REWORKED. THERE WERE 16 AREAS
PTABLE.

S FAILED (ALL OF THE TESTS INDICATED THE MATERIAL WAS BELOW
THAT FAILED WERE REWORKED. ALL AREAS WERE RETESTED AND

S ACCEPTANCE TESTS - DIKES

| MPACTION ① ③ | | WATER CONTENT ③ | | | | DEVIATION FROM OPTIMUM ③ | | | |
|---|---|---|---|---|---|---|---|---|---|
| ERAGE | DESIGN | HIGH | LOW | AVERAGE | DESIGN | HIGH | LOW | AVERAGE | SPECIFIED |
| 7.8 | 95.0 | 21.1 | 8.0 | 14.3 | 20.2 | +1.0 | -1.2 | +.59 | -2.0 +2.0 |
| 5.1 | 80.0 | N/A ② | N/A ② | N/A ② | N/A ② | N/A ② | N/A ② | N/A ② | N/A ② N/A |

ERIAL 0 TESTS FAILED.

FAILED.

N MATERIAL, RELATIVE DENSITY TEST USED ON THE PERVIOUS MATERIAL.

D INDICATE RESULTS OF ACCEPTABLE TESTS AND RETESTS FOR AVERAGE VALUES

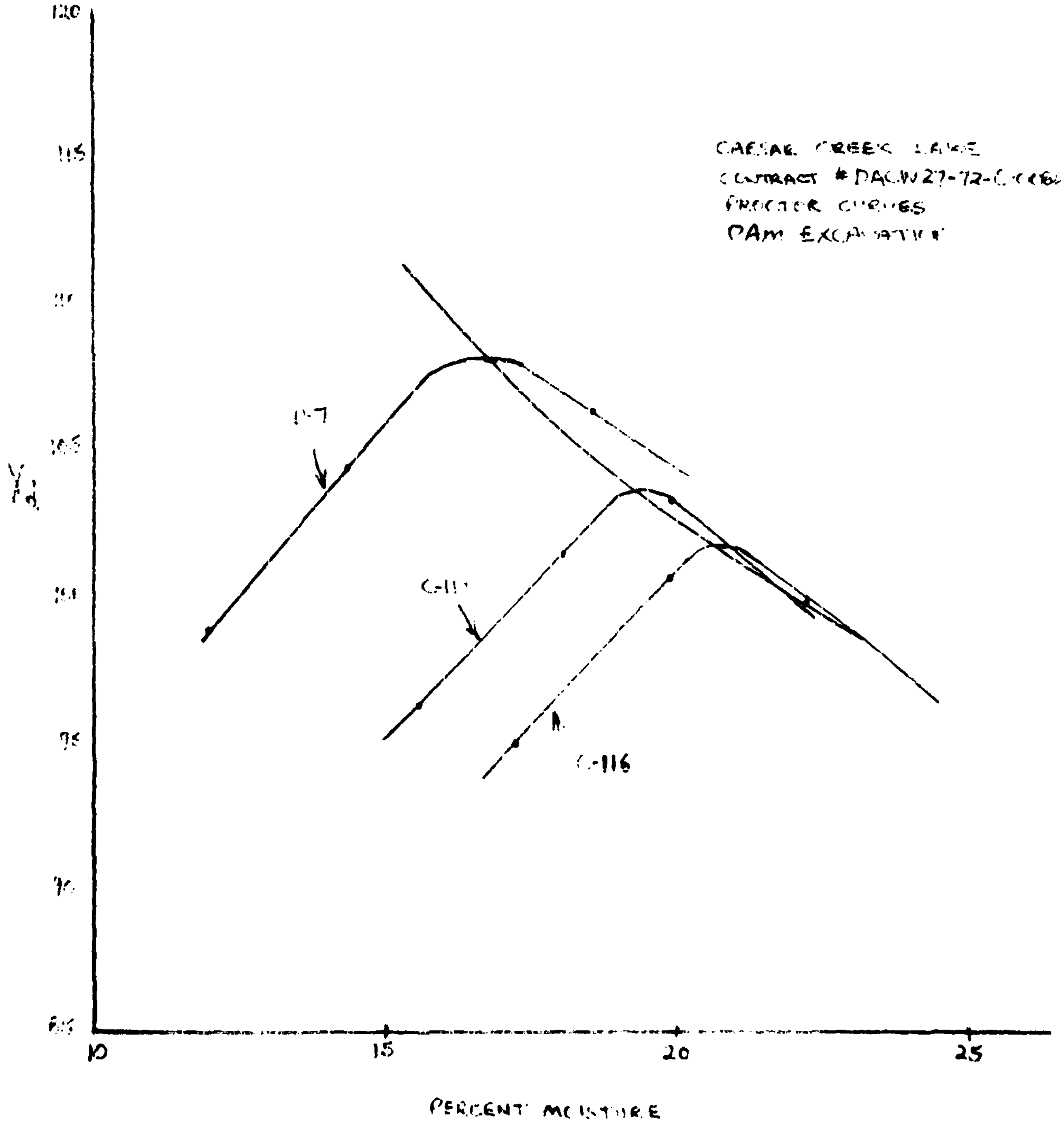
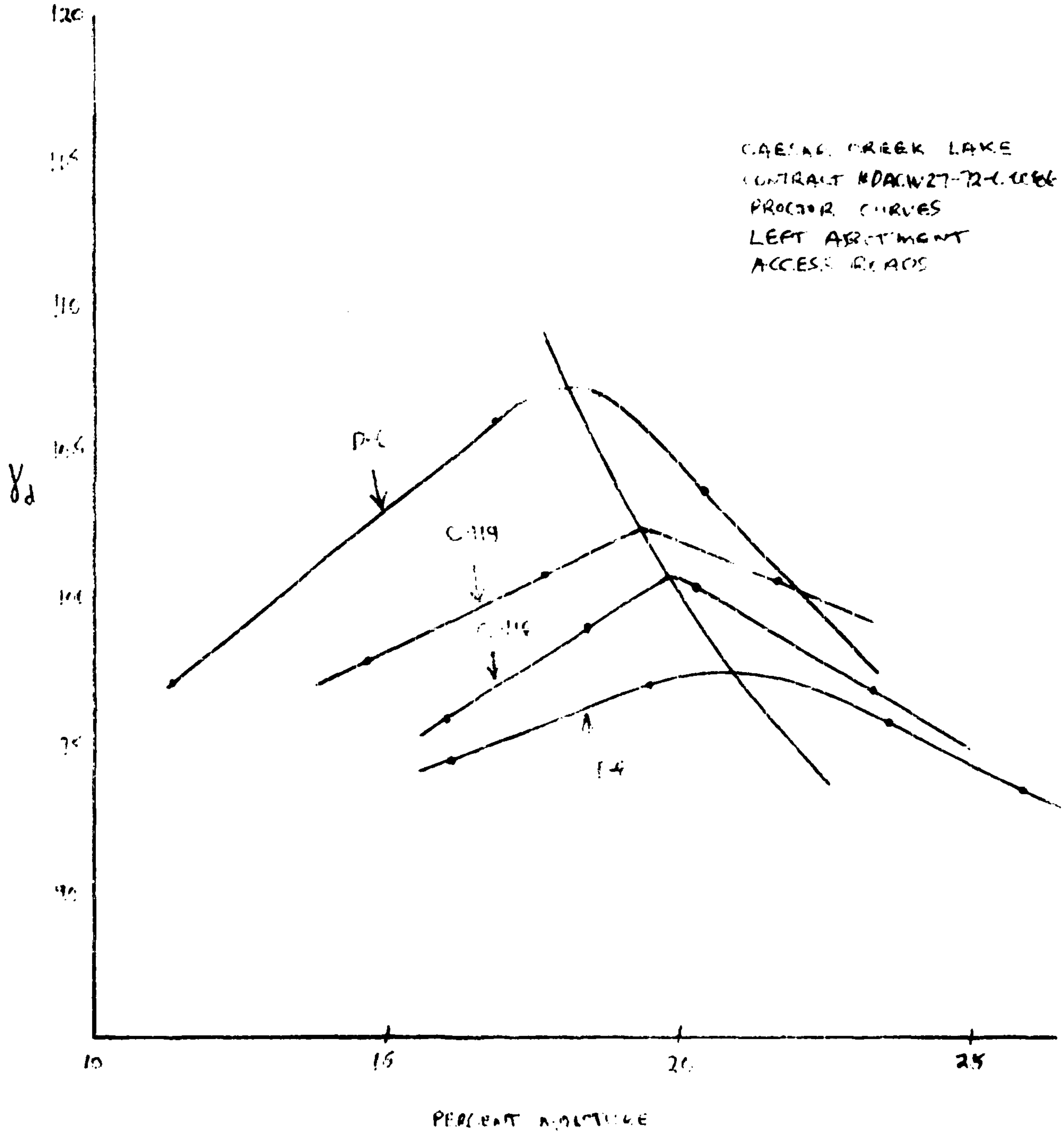

CAESAR CREEK LAKE
CONTRACT #DACW27-72-C-0068
PROCTOR CURVES
DAM EXCAVATION
P-7
C-116
$\gamma_d$
120
115
105
95
90
10
15
20
25
PERCENT MOISTURE

PLATE 24


CAESAR CREEK LAKE
CONTRACT #DACW27-72-C-0066
PROCTOR CURVES
LEFT ABUTMENT
ACCESS ROADS
120
110
105
100
95
90
10
15
20
25
PERCENT MOISTURE
C-119
A

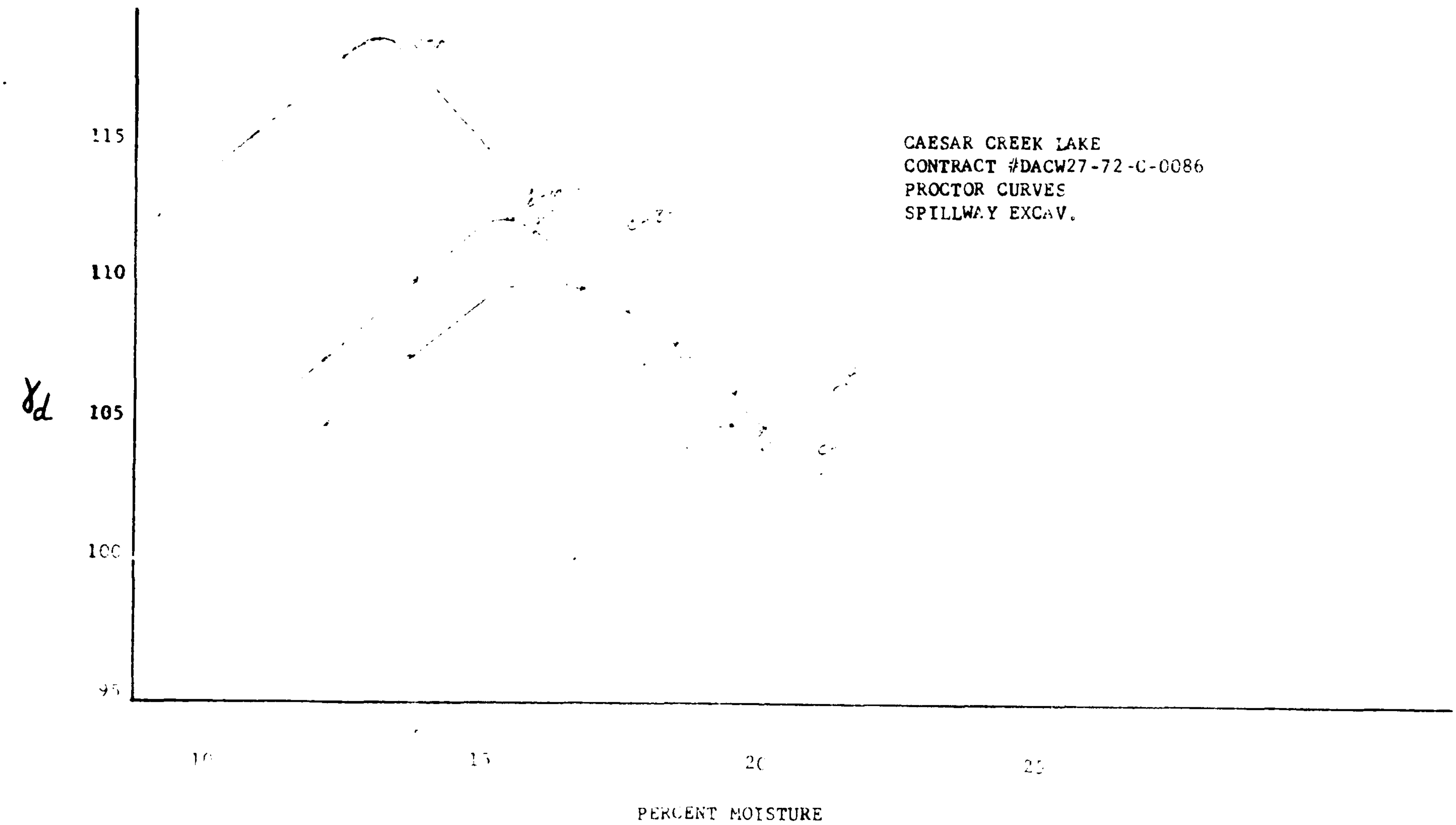
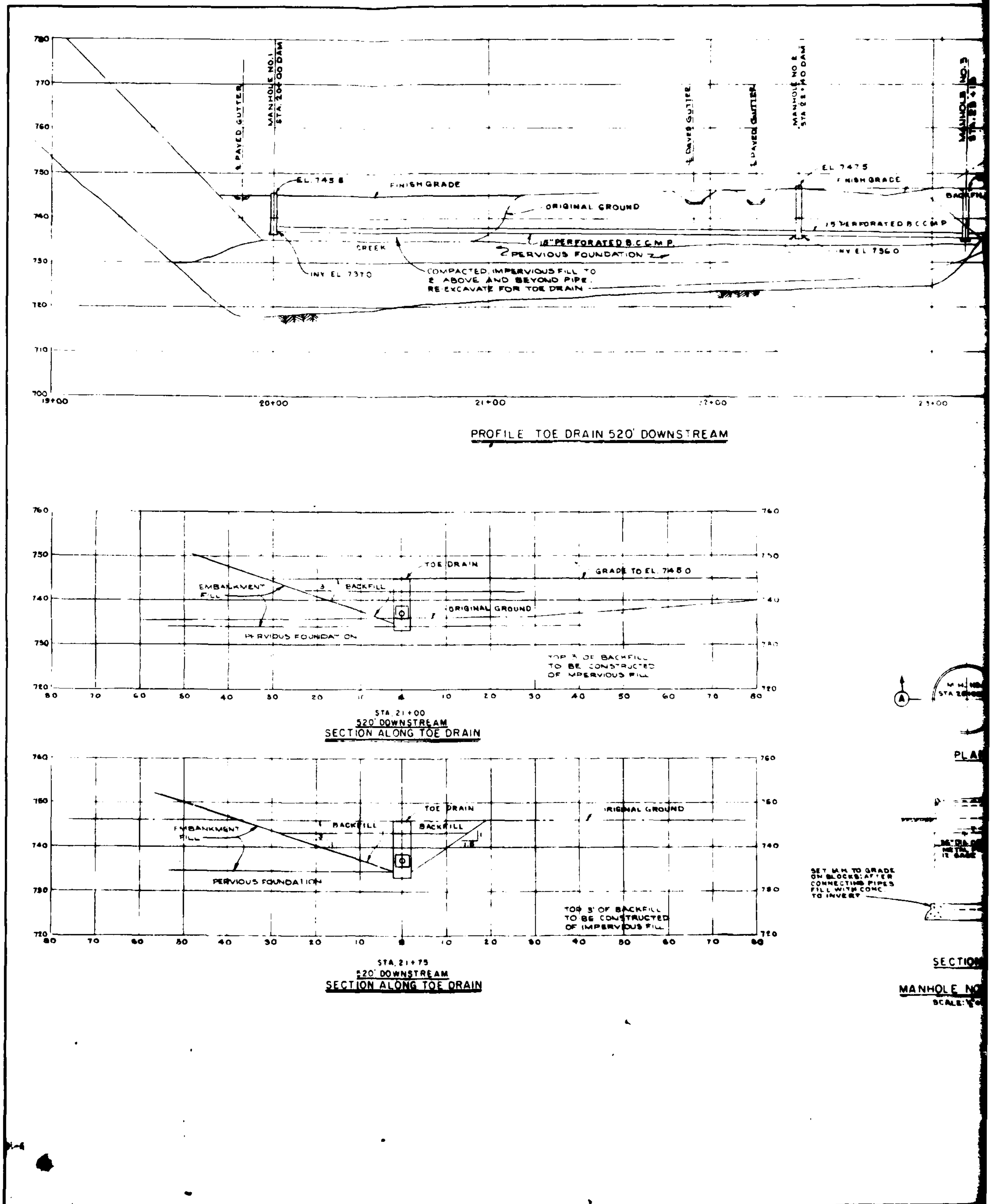
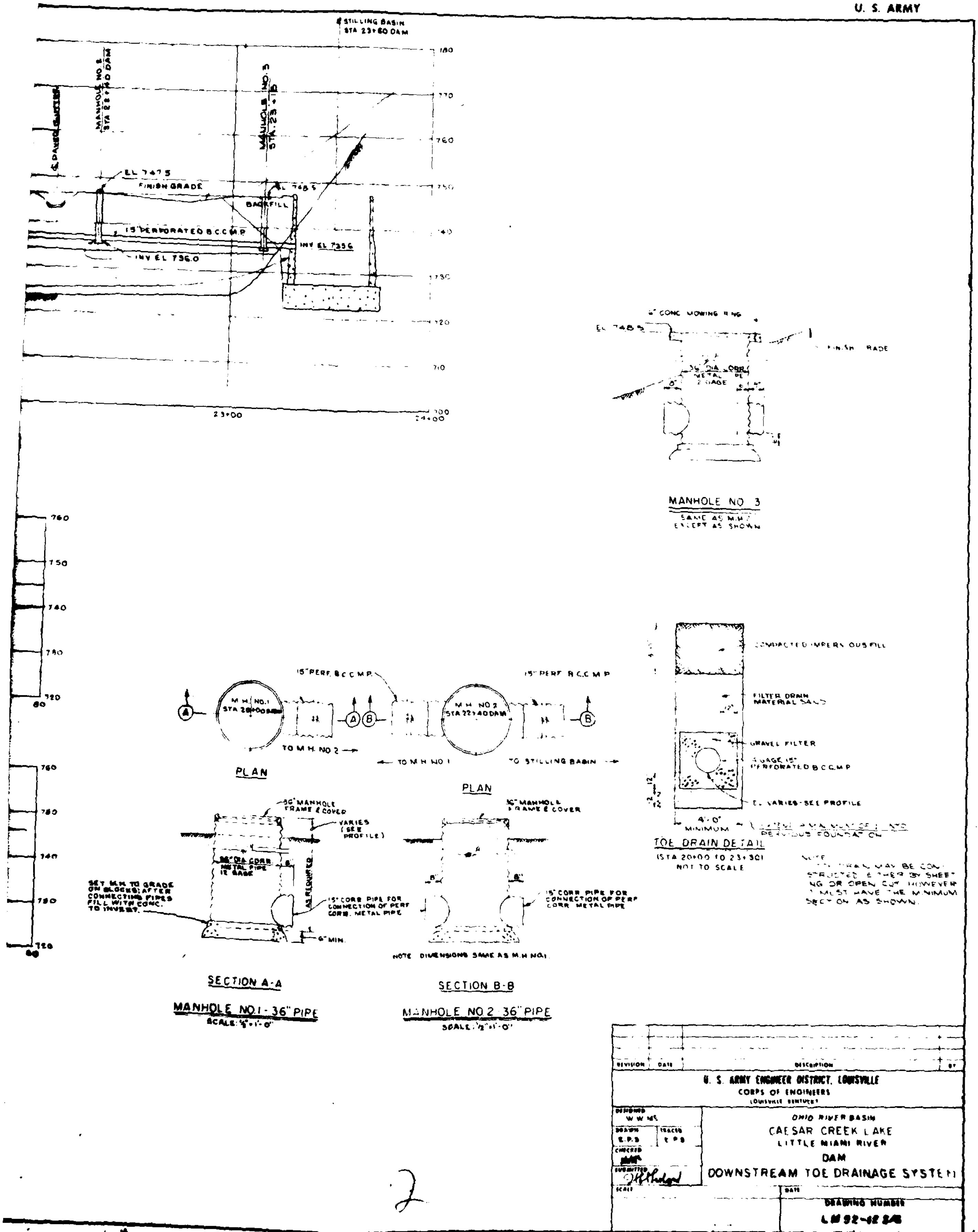

CAESAR CREEK LAKE
CONTRACT #DACW27-72-C-0086
PROCTOR CURVES
SPILLWAY EXCAV.
115
110
105
100
95
$\gamma_d$
10
15
20
25
PERCENT MOISTURE

PLATE 26

CORPS OF ENGINEERS





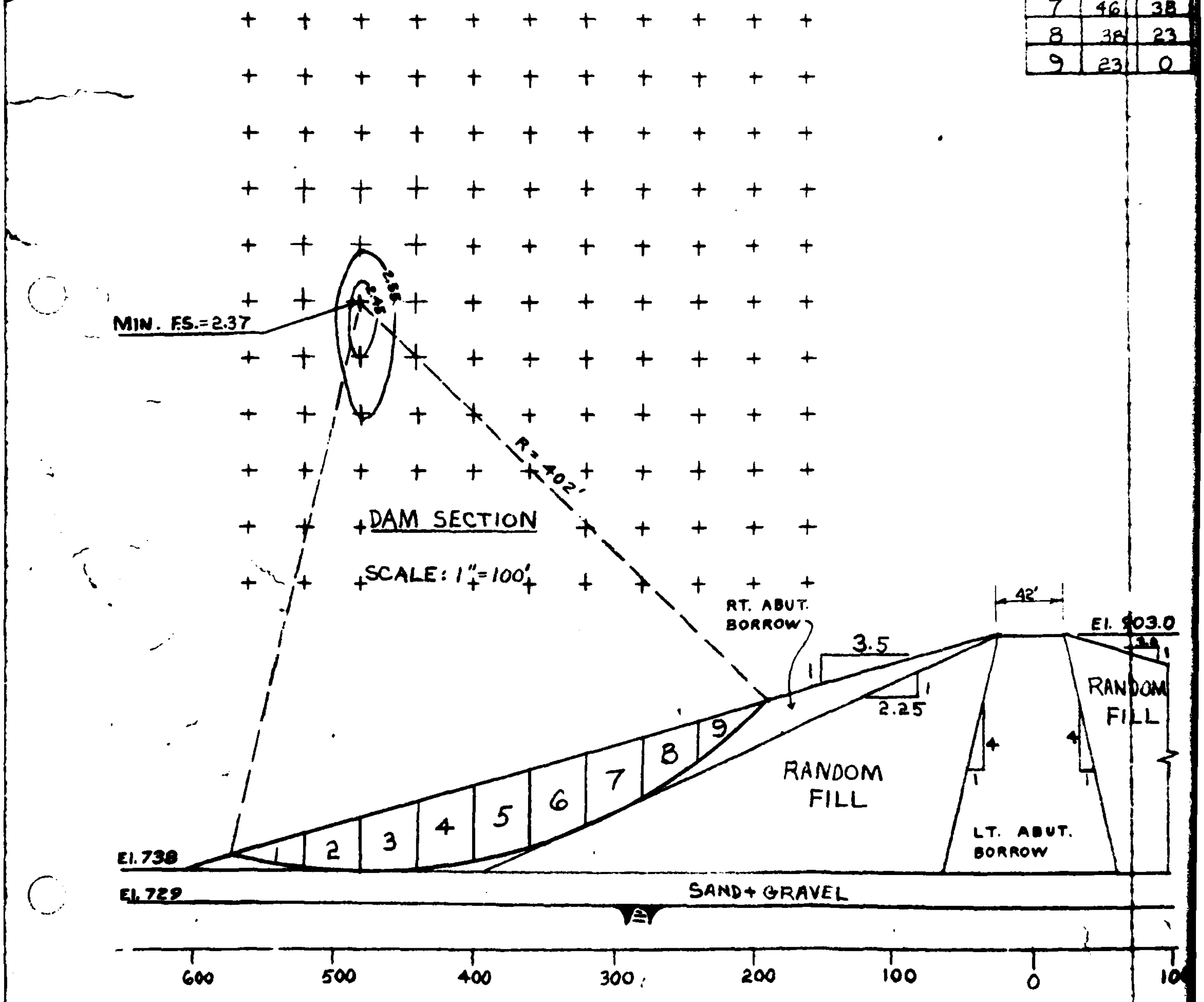
U. S. ARMY
STILLING BASIN STA 23+60 DAM
MANHOLE NO 3 STA 23+15
EL 747.5
FINISH GRADE
BACKFILL
15" PERFORATED B.C.C.M.P.
INV EL 736.0
INV EL 735.6
23+00
24+00
4" CONC MOWING RING
MANHOLE NO 3
SAME AS M.H. 2 EXCEPT AS SHOWN
COMPACTED IMPERVIOUS FILL
FILTER DRAIN MATERIAL SAND
GRAVEL FILTER
PERFORATED B.C.C.M.P.
EL VARIES-SEE PROFILE
4'-0" MINIMUM
TOE DRAIN DETAIL
(STA 20+00 TO 23+30)
NOT TO SCALE
15" PERF. B.C.C.M.P.
M.H. NO.1 STA 20+00 DAM
M.H. NO 2 STA 22+40 DAM
TO M.H. NO 2
TO M.H. NO 1
TO STILLING BASIN
PLAN
PLAN
36" MANHOLE FRAME & COVER
VARIES (SEE PROFILE)
36" DIA CORR. METAL PIPE 12 GAGE
SET M.H. TO GRADE ON BLOCKS. AFTER CONNECTING PIPES FILL WITH CONC. TO INVERT.
15" CORR PIPE FOR CONNECTION OF PERF CORR. METAL PIPE
6" MIN.
NOTE: DIMENSIONS SAME AS M.H. NO.1
SECTION A-A
SECTION B-B
MANHOLE NO.1 - 36" PIPE
SCALE: ½"=1'-0"
MANHOLE NO.2 36" PIPE
SCALE: ½"=1'-0"
REVISION
DATE
DESCRIPTION
BY
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
DESIGNED W.W.M.
DRAWN E.P.S.
TRACED E.P.S.
CHECKED
SUBMITTED
SCALE
DATE
OHIO RIVER BASIN
CAESAR CREEK LAKE
LITTLE MIAMI RIVER
DAM
DOWNSTREAM TOE DRAINAGE SYSTEM
DRAWING NUMBER


PLATE 27

CHKD. BY ______ DATE ______ JOB NO. ______

| ADOPTED DESIGN VALUES | | | | | | |
|---|---|---|---|---|---|---|
| MATERIAL | γ (PCF) | | | "Q" STRENGTH | | |
| | MOIST | SAT | SUB | TAN Ø | Ø° | "C" (TSF) |
| RT. ABUT. BORROW | 132.5 | 134.6 | 72.2 | 0.130 | 7.4 | 1.00 |
| LT. ABUT. BORROW | 127.0 | 129.0 | 66.6 | 0.071 | 4.0 | 1.13 |
| RANDOM FILL | 135.0 | 140.0 | 77.6 | 0.368 | 20.2 | 1.05 |

| SLICE NO. | HT. LT. SIDE (FT) | HT. RT. SIDE (FT) |
|---|---|---|
| 1 | 0 | 20 |
| 2 | 20 | 34 |
| 3 | 34 | 43 |
| 4 | 43 | 48 |
| 5 | 48 | 50 |
| 6 | 50 | 46 |
| 7 | 46 | 38 |
| 8 | 38 | 23 |
| 9 | 23 | 0 |



# MANUAL COMPUTATION FOR CRITICAL CIRCLE

| HT. RT. SIDE (FT) | AVG. HT. (FT) | WIDTH (FT) | AREA $(FT)^2$ | $\bar{X}$ (FT) | $SIN\theta$ $\bar{X}/R$ R-402' | $COS\theta$ | NORMAL FORCE $\gamma$ EFF (PCF) | W EFF (KIPS) | N EFF (W COS$\theta$) (KIPS) | TAN$\phi$ | $N_{EFF}$ TAN$\phi$ (KIPS) | COHESION ARC LENGTH (FT) | C (KSF) | CL (KIPS) | TANGENTIAL FORCE $\gamma_T$ (PCF) | $W_T$ (KIPS) | T (W SIN$\theta$) (KIPS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | 10.0 | 43.0 | 430.0 | -54.3 | -.135 | .991 | 132.5 | 57.0 | 56.5 | .130 | 7.3 | 44.0 | 2.00 | 88.0 | 132.5 | 57.0 | -7.7 |
| 34 | 27.0 | 40.0 | 1080.0 | -18.2 | -.045 | .999 | | 143.1 | 143.0 | | 18.6 | 40.0 | | 80.0 | | 143.1 | -6.4 |
| 43 | 38.5 | | 1540.0 | 20.8 | .052 | .999 | | 204.1 | 203.9 | | 26.5 | 40.5 | | 81.0 | | 204.1 | 10.6 |
| 48 | 45.5 | | 1820.0 | 60.4 | .150 | .989 | | 241.2 | 238.5 | | 31.0 | 41.0 | | 82.0 | | 241.2 | 36.2 |
| 50 | 49.0 | | 1960.0 | 100.0 | .249 | .969 | | 259.7 | 251.6 | | 32.7 | 41.5 | | 83.0 | | 259.7 | 64.7 |
| 46 | 48.0 | | 1920.0 | 139.8 | .348 | .937 | | 254.4 | 238.4 | | 31.0 | 43.0 | | 86.0 | | 254.4 | 88.5 |
| 38 | 42.0 | | 1680.0 | 179.3 | .446 | .895 | | 222.6 | 199.2 | | 25.9 | 45.0 | | 90.0 | | 222.6 | 99.3 |
| 23 | 30.5 | 40.0 | 1220.0 | 218.1 | .543 | .840 | | 161.7 | 135.8 | | 17.7 | 48.0 | | 96.0 | | 161.7 | 87.8 |
| 0 | 11.5 | 39.0 | 448.5 | 253.0 | .629 | .777 | 132.5 | 59.4 | 46.1 | .130 | 6.0 | 52.0 | 2.00 | 104.0 | 132.5 | 59.4 | 37.4 |
| | | | | | | | $\Sigma N_{EFF}$ TAN$\phi$ = 196.7 | | | | | $\Sigma$CL = 790.0 | | | $\Sigma$T = 410.4 | | |

$$F.S. = \frac{\Sigma N_{EFF} TAN\phi + \Sigma CL}{\Sigma T} = \frac{196.7+790.0}{410.4} = \frac{986.7}{410.4} = 2.40 \sim 2.37$$

NOTES:

1. Slope stability computations made with I.B.M. 360 electronic computer using program No. 41-K2-H203. The stability of the critical circle was checked with the manual computation shown.

2. A search by the computer showed the most critical type of failure to be an embankment failure tangent to the sand and gravel at elevation 738.

3. Centers of all base circles are shown along with "Factor of Safety Contours." The critical circle is shown on the embankment cross section.

CAESAR CREEK RES.

STABILITY ANALYSIS
FINITE SLICE METHOLD
END OF CONSTRUCTION

P.L.N. OCT. 1969

2

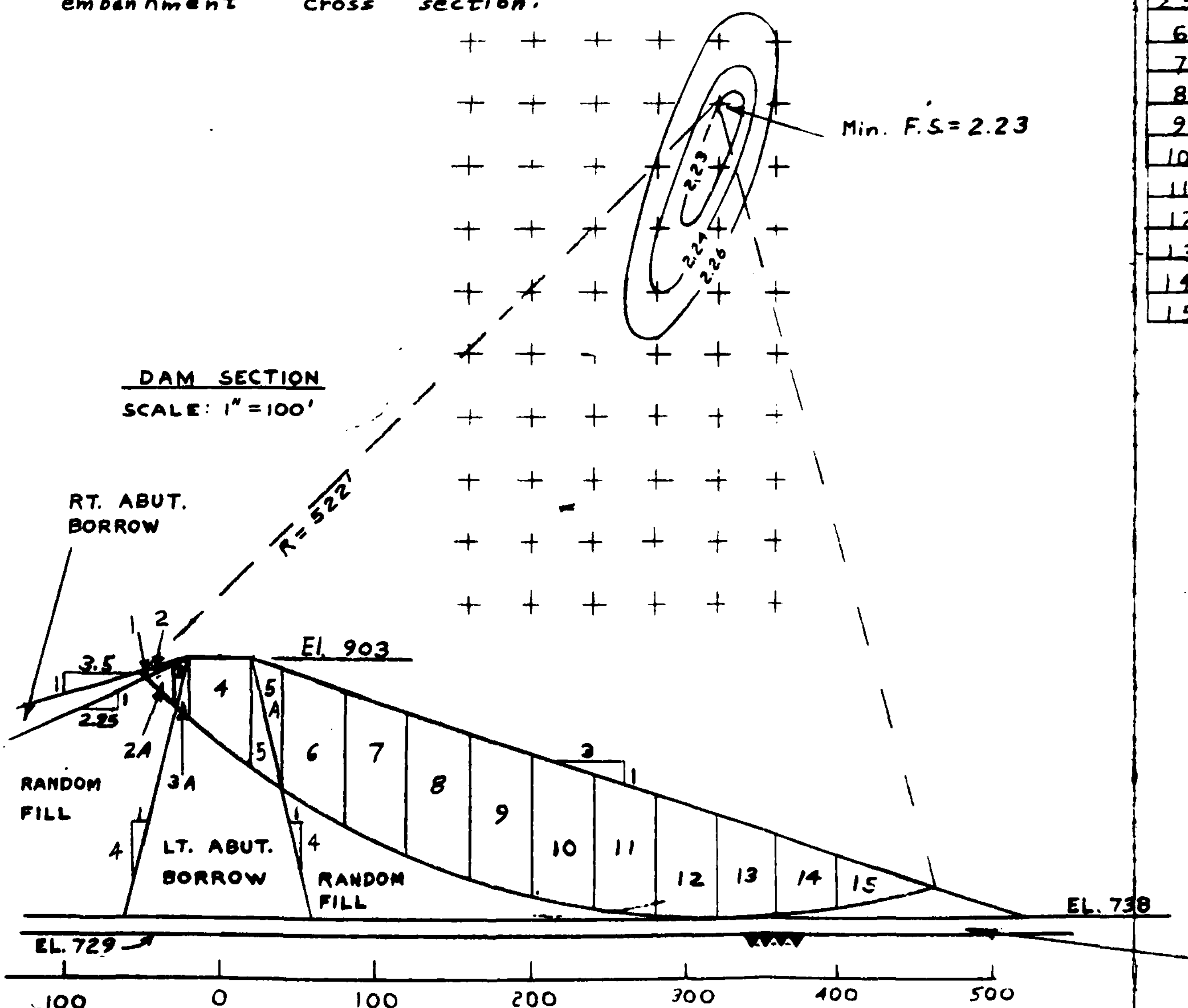
CHKD. BY ........ DATE ........ .................................... JOB NO. ..................

NOTES:

1. Slope stability computations were made with an IBM 360 electronic computer using program No. 41-K2-H203. The stability of the critical circle was checked with the manual computation shown.

2. A search by the computer showed the most critical type of failure to be an embankment failure tangent to the sand and gravel at elevation 738.

3. Centers of base circles are shown along with "Factor of Safety Contours." The critical circle is shown on the embankment cross section.




| SLICE NO. |
|---|
| 1 |
| 2 |
| 2A |
| Σ 2 |
| 3 |
| 3A |
| Σ 3 |
| 4 |
| 5 |
| 5A |
| Σ 5 |
| 6 |
| 7 |
| 8 |
| 9 |
| 10 |
| 11 |
| 12 |
| 13 |
| 14 |
| 15 |

## MANUAL COMPUTATION FOR CRITICAL CIRCLE

| SLICE NO. | HT. LT. SIDE (FT.) | HT. RT. SIDE (FT.) | AVG HT. (FT.) | WIDTH (FT) | AREA ($FT^2$) | $\bar{X}$ (FT) | SIN θ $\bar{X}/R$ R=522 | COS θ | NORMAL FORCE $\gamma_{EFF}$ (PCF) | $W_{EFF}$ (KIPS) | $N_{EFF}$ (W COS θ) (KIPS) | TAN φ | $N_{EFF}$ TAN φ (KIPS) | COHESION ARC LENGTH (FT) | C (KSF) | CL (KIPS) | TANGENTIAL FORCE $\gamma_T$ (PCF) | $W_T$ (KIPS) | T (W SIN θ) (KIPS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 4 | 2.0 | 3.0 | 6.0 | 372.0 | 0.713 | 0.701 | 132.5 | 0.8 | 0.6 | 0.13[illegible] | 0.1 | 4.5 | 2.00 | 9.0 | 132.5 | 0.8 | 0.6 |
| 2 | 4 | 0 | 2.0 | 21.0 | 42.0 | 363.0 | 0.695 | 0.719 | 132.5 | 5.6 | 4.0 | | | | | | 132.5 | 5.6 | 3.9 |
| 2A | 0 | 28 | 14.0 | 21.0 | 294.0 | 356.0 | 0.682 | 0.731 | 135.0 | 39.7 | [illegible] | | | | | | 135.0 | 39.7 | 27.1 |
| 2 | | | | | | | | | | | 33.0 | 0.368 | [illegible] | 27.5 | 2.10 | 57.8 | | | |
| 3 | 28 | 0 | 14.0 | 8.0 | 112.0 | 346.3 | 0.663 | 0.749 | 135.0 | [illegible] | 11.3 | | | | | | 135.0 | 15.1 | 10.[illegible] |
| 3A | 0 | 38 | 19.0 | 8.0 | 152.0 | 343.7 | 0.658 | 0.753 | 127.0 | 19.[illegible] | 14.5 | | | | | | 127.0 | [illegible].3 | 12.7 |
| 3 | | | | | | | | | | | 25.8 | 0.071 | 1.8 | 10.0 | 2.26 | 22.6 | | | |
| 4 | 38 | 70 | 54.0 | 41.0 | 2214.0 | 318.5 | 0.610 | 0.792 | 127.0 | 281.2 | 222.7 | 0.071 | 15.3 | 53.0 | 2.26 | 115.[illegible] | 127.0 | 281.2 | 17[illegible].5 |
| 5 | 70 | 0 | 35.0 | 22.0 | 770.0 | 292.7 | 0.561 | 0.828 | 127.0 | 97.8 | 81.0 | | | | | | 127.0 | 97.8 | 54.[illegible] |
| 5A | 0 | 78 | 39.0 | 22.0 | 858.0 | 285.3 | 0.547 | 0.837 | 135.0 | 115.8 | 96.9 | | | | | | 135.0 | 115.8 | 63.3 |
| 5 | | | | | | | | | | | 177.9 | 0.071 | 12.6 | 26.0 | 2.26 | 58.8 | | | |
| 6 | 78 | 87 | 82.5 | 38.0 | 3135.0 | 258.7 | 0.496 | 0.868 | 135.0 | 423.2 | 367.3 | 0.368 | 135.2 | 44.0 | 2.1[illegible] | 92.4 | 135.0 | 423.2 | 209.9 |
| 7 | 87 | 92 | 89.5 | 40.0 | 3580.0 | 219.9 | 0.421 | 0.907 | 135.0 | 483.3 | 433.4 | 0.368 | 161.3 | 45.0 | 2.10 | 94.5 | 135.0 | 483.3 | 203.5 |
| 8 | 92 | 93 | 92.5 | 40.0 | 3700.0 | 180.0 | 0.345 | 0.939 | 135.0 | 499.5 | 469.0 | 0.368 | 172.6 | 43.0 | 2.10 | 90.[illegible] | 135.0 | 499.5 | 172.[illegible] |
| 9 | 93 | 91 | 92.0 | 40.0 | 3680.0 | 140.1 | 0.268 | 0.963 | 135.0 | 496.8 | 478.4 | 0.368 | 176.1 | 42.0 | 2.1[illegible] | [illegible] | 135.0 | 496.[illegible] | 123.1 |
| 10 | 91 | 86 | 88.5 | 40.0 | 3540.0 | 100.2 | 0.192 | 0.981 | 135.0 | 477.9 | 468.8 | 0.368 | 172.5 | 41.0 | 2.1[illegible] | 86.1 | 135.0 | 477.9 | 91.8 |
| 11 | 86 | 77 | 81.5 | 40.0 | 3260.0 | 60.4 | 0.116 | 0.993 | 135.0 | 440.1 | 437.0 | 0.368 | 160.8 | 40.0 | 2.1[illegible] | 84.0 | 135.[illegible] | 440.1 | 51.1 |
| 12 | 77 | 66 | 71.5 | 40.0 | 2860.0 | 20.5 | 0.039 | 0.999 | 135.0 | 386.1 | 385.7 | [illegible] | 141.9 | 40.0 | 2.10 | 84.0 | [illegible] | 386.1 | 15.1 |
| 13 | 66 | 50 | 58.0 | 40.0 | 2320.0 | -19.1 | -0.037 | 0.999 | 135.0 | 313.2 | 312.9 | 0.368 | 115.1 | 40.0 | 2.10 | 84.[illegible] | 135.[illegible] | 313.2 | -11.6 |
| 14 | 50 | 33 | 41.5 | 40.0 | 1660.0 | -58.6 | -0.112 | 0.994 | 135.0 | 224.1 | 222.8 | 0.368 | 82.0 | 40.0 | 2.10 | 84.[illegible] | 135.[illegible] | 224.1 | -25.[illegible] |
| 15 | 33 | 0 | 16.5 | 60.0 | 990.0 | -71.0 | -0.136 | 0.991 | 135.0 | 133.7 | 132.5 | 0.368 | 48.8 | 60.0 | 2.10 | 12[illegible] | 135.0 | 133.7 | -1[illegible].2 |
| | | | | | | | | | | | | Σ | 1408.7 | | Σ | 1181.5 | | Σ | 1165.9 |

$$F.S. = \frac{\Sigma N_{EFF}\ TAN\ \phi + CL}{\Sigma T} = \frac{1408.7 + 1181.5}{1165.9} = 2.22$$

| ADOPTED DESIGN VALUES | | | | | |
|---|---|---|---|---|---|
| MATERIAL | γ (PCF) MOIST | SAT. | SUBM. | "Q" STRENGTH TAN φ | C (TSF) |
| RT. ABUT. BORROW | 132.5 | 134.6 | 72.2 | 0.130 | 1.00 |
| LT. ABUT. BORROW | 127.0 | 129.0 | 66.6 | 0.071 | 1.13 |
| RANDOM FILL | 135.0 | 140.0 | 77.6 | 0.368 | 1.05 |

Sand & Gravel

2

CAESAR CREEK RESERVOIR
STABILITY ANALYSIS
FINITE SLICE METHOD
END OF CONSTRUCTION

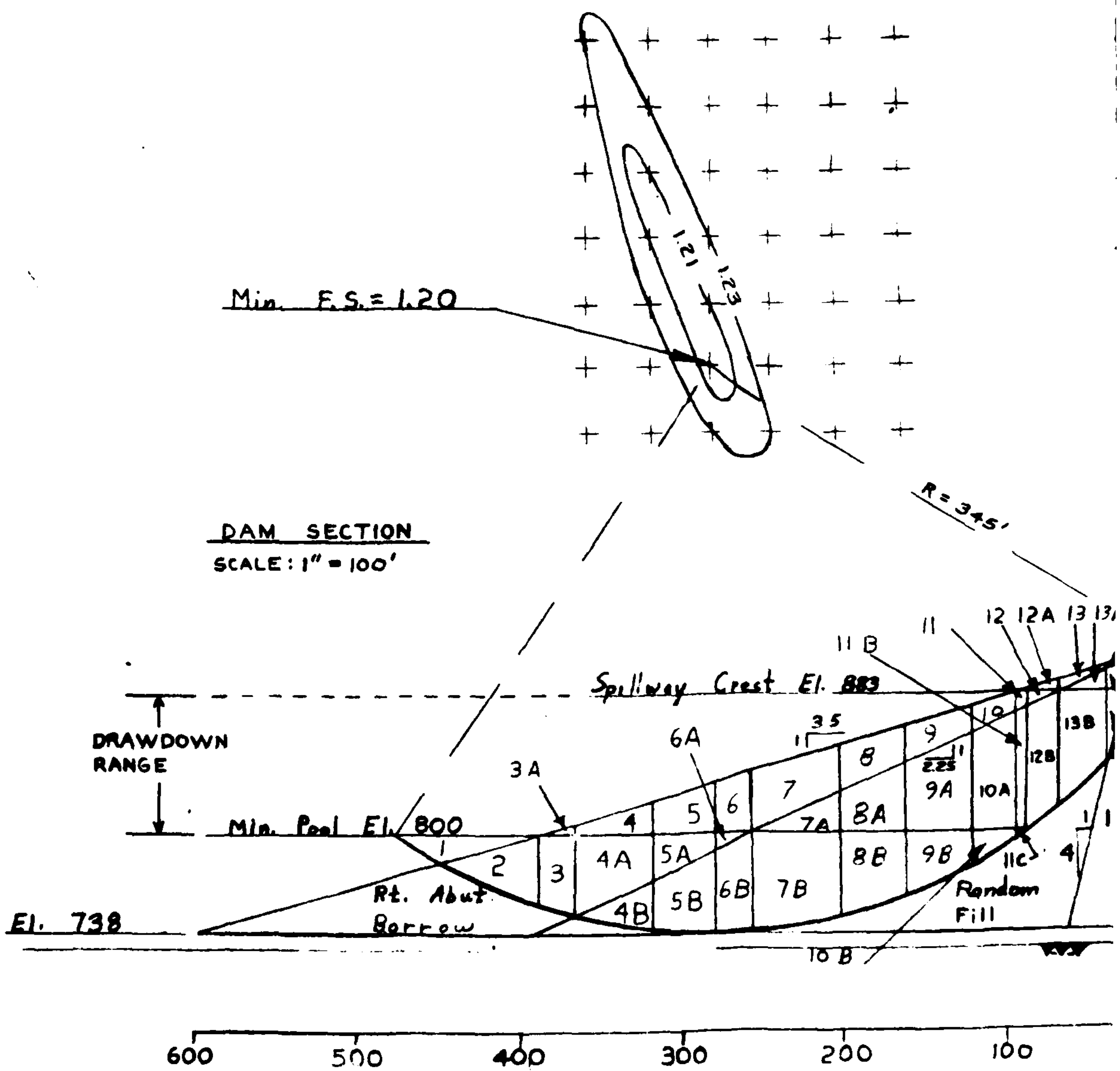
GVF

OCT., 1969

D.M. NO. 5 PLATE 28

CHKD. BY ______ DATE ______ JOB NO. ______

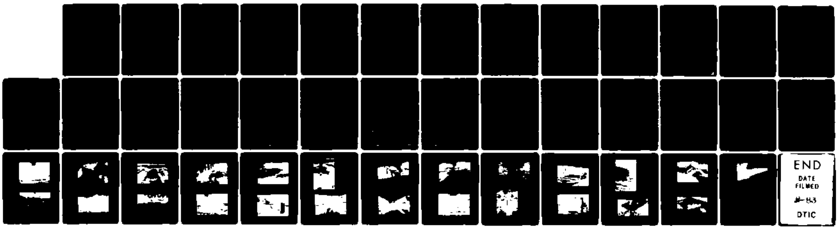
| ADOPTED DESIGN VALUES | | | | | | |
|---|---|---|---|---|---|---|
| MATERIALS | γ (PCF) | | | STRENGTH | | |
| | MOIST | SAT | SUBM | TEST | TAN φ | C (TSF) |
| RT. ABUT. BORROW | 132.5 | 134.6 | 72.2 | R | 0.375 | 0.30 |
| LT. ABUT. BORROW | 127.0 | 129.0 | 66.6 | R | 0.287 | 0.19 |
| RANDOM FILL | 135.0 | 140.0 | 77.6 | R | 0.330 | 0.50 |

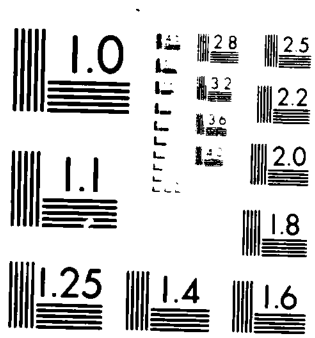


AD-A122 733 CAESAR CREEK LAKE LITTLE MIAMI RIVER BASIN OHIO EMBANKMENT CRITERIA AND PERFORMANCE REPORT(U) ARMY ENGINEER DISTRICT LOUISVILLE KY SEP 82

2/2

UNCLASSIFIED F/G 13/2 NL





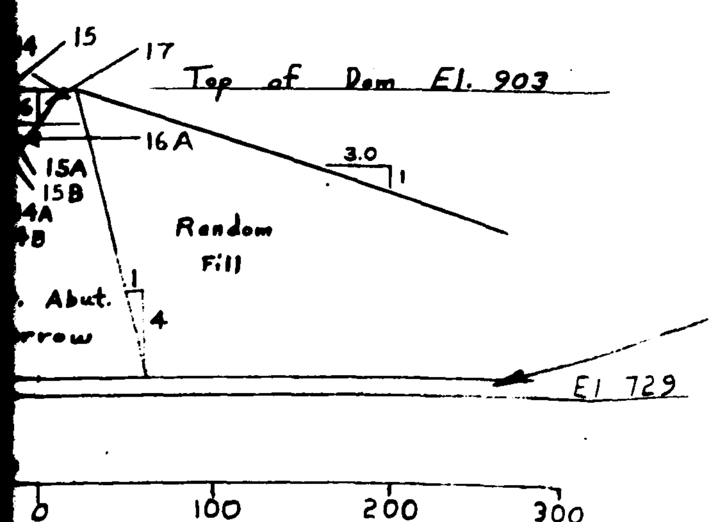

MICROCOPY RESOLUTION TEST CHART

NOTES:

1. Slope stability computations were made with an IBM 360 electronic computer using program No. 41-K2-H203. The stability of the critical circle was checked with the manual computation shown.

2. A search by the computer showed the most critical type of failure for sudden drawdown to be an embankment failure tangent to the sand and gravel at elevation 738.

3. Centers of all base circle are shown along with "Factor of Safety Contours." The critical circle is shown on the embankment cross section.




CAESAR CREEK RESERVOIR

STABILITY ANALYSIS

FINITE SLICE METHOD

SUDDEN DRAWDOWN

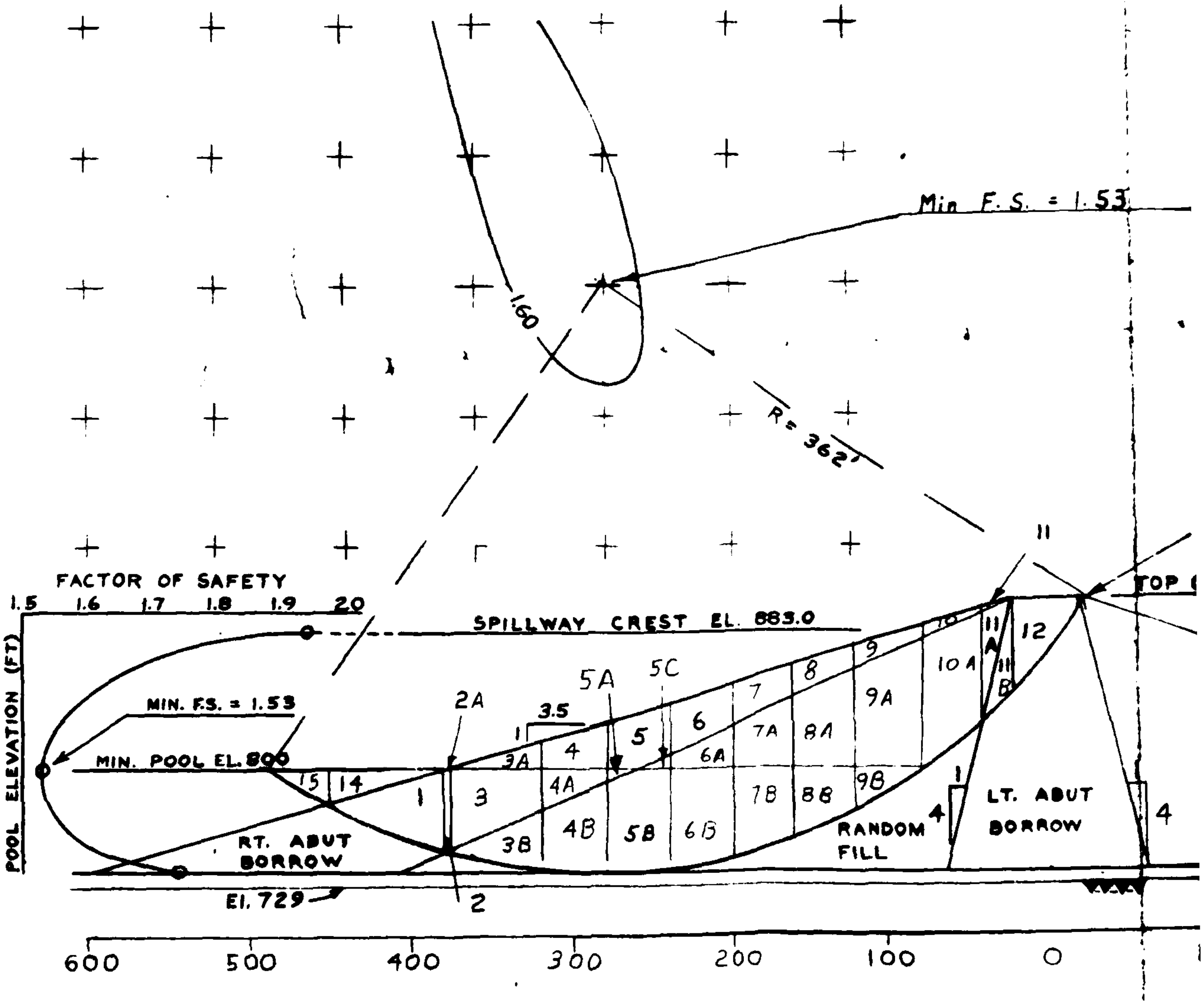
G.V.F. SHEET 1 OF 2 NOV. 1969

2

CHKD. BY........DATE.........

JOB NO. ...................

| ADOPTED DESIGN VALUES | | | | | |
|---|---|---|---|---|---|
| MATERIALS | $\gamma$ (PCF) | | "R" STRENGTH | | |
| | MOIST | SAT | TEST | TAN $\phi$ | C(TSF) |
| RT. ABUT. BORROW | 132.5 | 134.6 | R | 0.375 | 0.30 |
| LT. ABUT BORROW | 127.0 | 129.0 | R | 0.287 | 0.19 |
| RANDOM FILL | 135.0 | 140.0 | R | 0.330 | 0.50 |



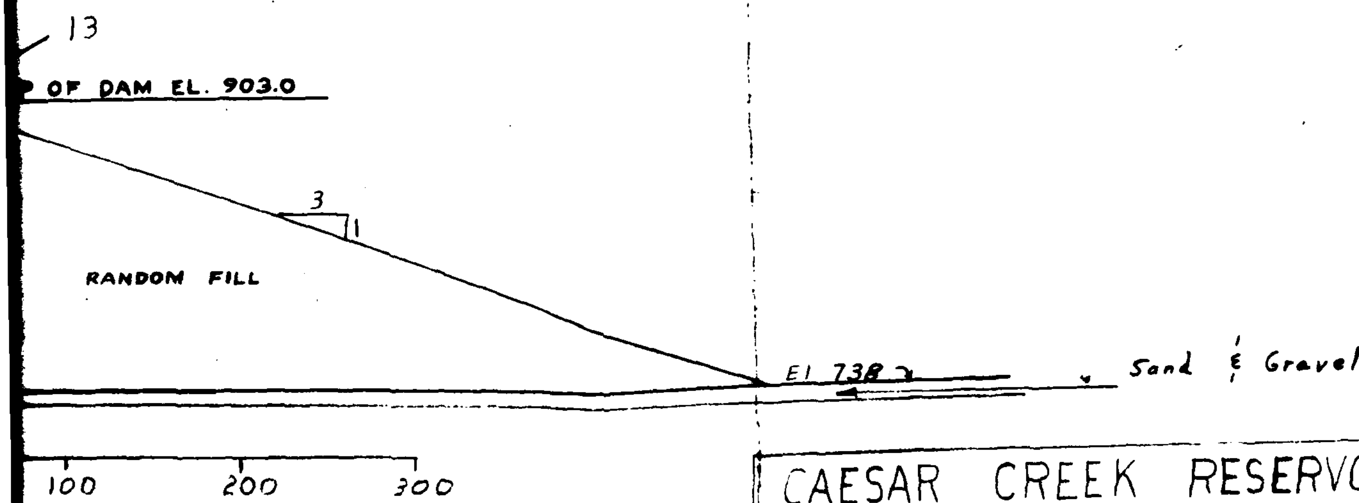

Scale: 1"=100'

NOTES:

1. Slope stability computations were made with an IBM 360 electronic computer using program No. 41-K2-H203. The stability of the critical circle was checked with the manual computation shown.

2. A search by the computer showed the most critical type of failure to be an embankment failure tangent to the sand and gravel at elevation 738.

3. Centers of all base circles are shown along with "Factor of Safety Contours". The critical circle is shown on the embankment cross section.




CAESAR CREEK RESERVOIR

STABILITY ANALYSIS

FINITE SLICE METHOD

**PARTIAL POOL**

GVF SHEET 1 OF 2 OCT., 1969

D.M. NO. 5 PLATE 38

2

CHKD. BY ________ DATE ________ JOB NO. ________

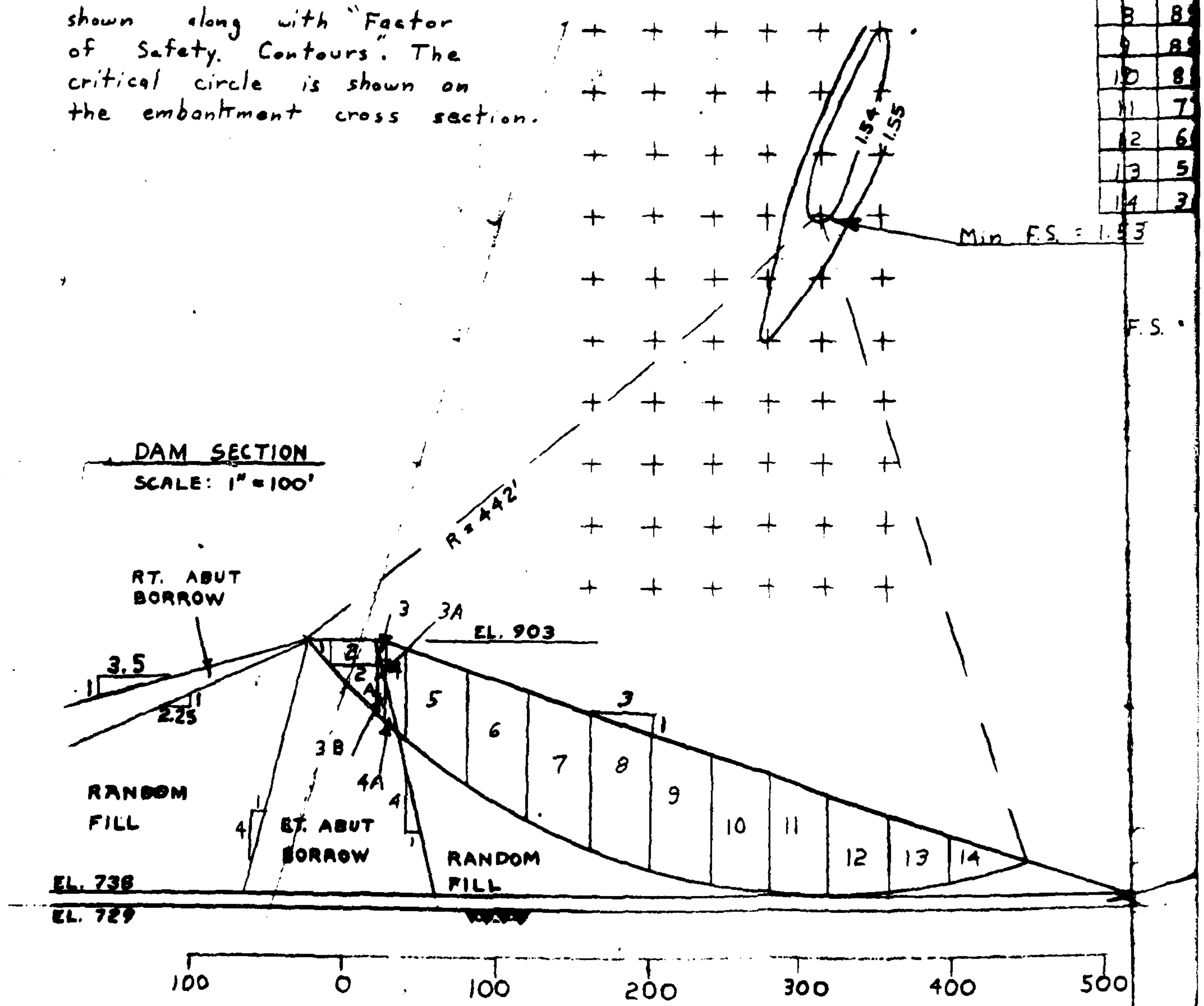
NOTES:

1. Slope stability computations were made with an IBM 360 electronic computer using program No. 41-K2-H203. The stability of the critical circle was checked with the manual computations shown.

2. A search by the computer showed the most critical type of failure for Steady Seepage to be an embankment failure tangent to the Sand and Gravel at elev. 738. The "R" case yielded a F.S. = 1.53 and the "S" case 2.01. Since the "S" case is greater than the "R" case, the average F.S. = (1.53 + 2.01)/2 = 1.77.

3. Centers of all base circles shown along with "Factor of Safety" Contours". The critical circle is shown on the embankment cross section.

| SLICE NO. | HT. SI E |
| --- | --- |
| 1 | 0 |
| 2 | 2 |
| 2A | 0 |
| 3 | 0 |
| 3A | 2 |
| 3B | 2 |
| 4 | 2 |
| 4A | 3 |
| 5 | 5 |
| 6 | 7 |
| 7 | 8 |
| 8 | 8 |
| 9 | 8 |
| 10 | 8 |
| 11 | 7 |
| 12 | 6 |
| 13 | 5 |
| 14 | 3 |



| HT. LT SIDE FT. | HT RT SIDE FT. | AVG HT FT. | WIDTH FT | AREA $FT^2$ | $\bar{X}$ FT | SIN θ $\bar{X}/R$ R=442 | COS θ | NORMAL FORCES $\gamma_{EFF}$ PCF | $W_{EFF}$ KIPS | $N_{EFF}$ $W_{EFF}$ COS θ KIPS | TAN ϕ | $N_{EFF}$ TAN ϕ KIPS | COHESION ARC LENGTH FT. | C KSF | CL KIPS | TANGENTIAL FORCES $\gamma$ PCF | WT. KIPS | T W SIN θ KIPS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 21 | 10.5 | 16 | 168 | 331 | .749 | .663 | 127.0 | 21.3 | 14.1 | .287 | 4.0 | 26 | .38 | 9.9 | 127.0 | 21.3 | 16.0 |
| 21 | 21 | 21 | 27 | 567 | 313 | .708 | .706 | 127.0 | 72.0 | 50.8 | .287 | 14.6 | 0 | .38 | 0 | 127.0 | 72.0 | 51.0 |
| 0 | 27 | 13.5 | 27 | 364.5 | 309 | .699 | .715 | 66.6 | 24.3 | 17.3 | .287 | 5.0 | 38 | .38 | 14.4 | 129.0 | 47.0 | 32.9 |
| 0 | 21 | 10.5 | 6 | 63 | 296 | .670 | .742 | 135.0 | 8.5 | 6.3 | .287 | 1.8 | 0 | .38 | 0 | 135.0 | 8.5 | 5.7 |
| 21 | 0 | 10.5 | 6 | 63 | 297 | .672 | .741 | 127.0 | 8.0 | 5.9 | .287 | 1.7 | 0 | .38 | 0 | 127.0 | 8.0 | 5.4 |
| 26 | 31 | 28.5 | 6 | 171 | 296 | .670 | .742 | 66.6 | 11.4 | 8.5 | .287 | 2.4 | 8 | .38 | 3.0 | 129.0 | 22.1 | 14.8 |
| 21 | 56 | 38.5 | 10 | 385 | 287 | .649 | .761 | 135.0 | 51.9 | 39.5 | .287 | 11.3 | 0 | .38 | 0 | 135.0 | 51.9 | 33.7 |
| 31 | 0 | 15.5 | 10 | 155 | 290 | .656 | .755 | 66.6 | 10.3 | 7.8 | .287 | 2.2 | 13 | .38 | 4.9 | 129.0 | 20.0 | 13.1 |
| 56 | 75 | 65.5 | 44 | 2882 | 261 | .590 | .807 | 135.0 | 389.0 | 313.9 | .330 | 103.6 | 55 | 1.0 | 55.0 | 135.0 | 389.0 | 229.5 |
| 75 | 84 | 79.5 | 40 | 3180 | 220 | .498 | .867 | 135.0 | 429.3 | 372.2 | .330 | 122.8 | 46 | 1.0 | 46.0 | 135.0 | 429.3 | 213.8 |
| 84 | 89 | 86.5 | 40 | 3460 | 180 | .407 | .913 | 135.0 | 467.1 | 426.5 | .330 | 140.7 | 44 | 1.0 | 44.0 | 135.0 | 467.1 | 190.1 |
| 89 | 89 | 89 | 40 | 3560 | 140 | .317 | .948 | 135.0 | 480.6 | 455.6 | .330 | 150.3 | 42 | 1.0 | 42.0 | 135.0 | 480.6 | 152.4 |
| 89 | 85 | 87 | 40 | 3480 | 100 | .226 | .974 | 135.0 | 469.8 | 457.6 | .330 | 151.0 | 42 | 1.0 | 42.0 | 135.0 | 469.8 | 106.2 |
| 85 | 77 | 81 | 40 | 3240 | 60 | .136 | .991 | 135.0 | 437.4 | 433.5 | .330 | 143.1 | 41 | 1.0 | 41.0 | 135.0 | 437.4 | 59.5 |
| 77 | 66 | 71.5 | 40 | 2860 | 20 | .045 | .999 | 135.0 | 386.1 | 385.7 | .330 | 127.3 | 40 | 1.0 | 40.0 | 135.0 | 386.1 | 17.4 |
| 66 | 51 | 58.5 | 40 | 2340 | -20 | -.045 | .999 | 135.0 | 315.9 | 315.6 | .330 | 104.1 | 40 | 1.0 | 40.0 | 135.0 | 315.9 | -14.2 |
| 51 | 31 | 41 | 40 | 1640 | -60 | -.136 | .991 | 135.0 | 221.4 | 219.4 | .330 | 72.4 | 40 | 1.0 | 40.0 | 135.0 | 221.4 | -30.1 |
| 31 | 0 | 15.5 | 53 | 821.5 | -98 | -.222 | .975 | 135.0 | 110.9 | 108.1 | .330 | 35.7 | 54 | 1.0 | 54.0 | 135.0 | 110.9 | -24.6 |
| | | | | | | | | | | | | Σ = 1194.0 | | | Σ = 476.2 | | | Σ = 1072.6 |

$$F.S. = \frac{\Sigma N_{EFF} \tan\phi + \Sigma CL}{\Sigma T} = \frac{1194.0 + 476.2}{1072.6} = 1.56$$

| ADOPTED DESIGN VALUES | | | | | | |
|---|---|---|---|---|---|---|
| MATERIALS | γ (PCF) | | | STRENGTH | | |
| | MOIST | SAT | SUBM | TEST | TAN ϕ | C (TSF) |
| LT. ABUT. BORROW | 132.5 | 134.6 | 72.2 | R | .375 | 0.30 |
| | | | | S | .547 | 0.00 |
| RT. ABUT BORROW | 127.0 | 129.0 | 66.6 | R | .287 | 0.19 |
| | | | | S | .454 | 0.00 |
| RANDOM FILL | 135.0 | 140.0 | 77.6 | R | .330 | 0.50 |
| | | | | S | .650 | 0.00 |

Sand & Gravel

CAESAR CREEK RESERVOIR

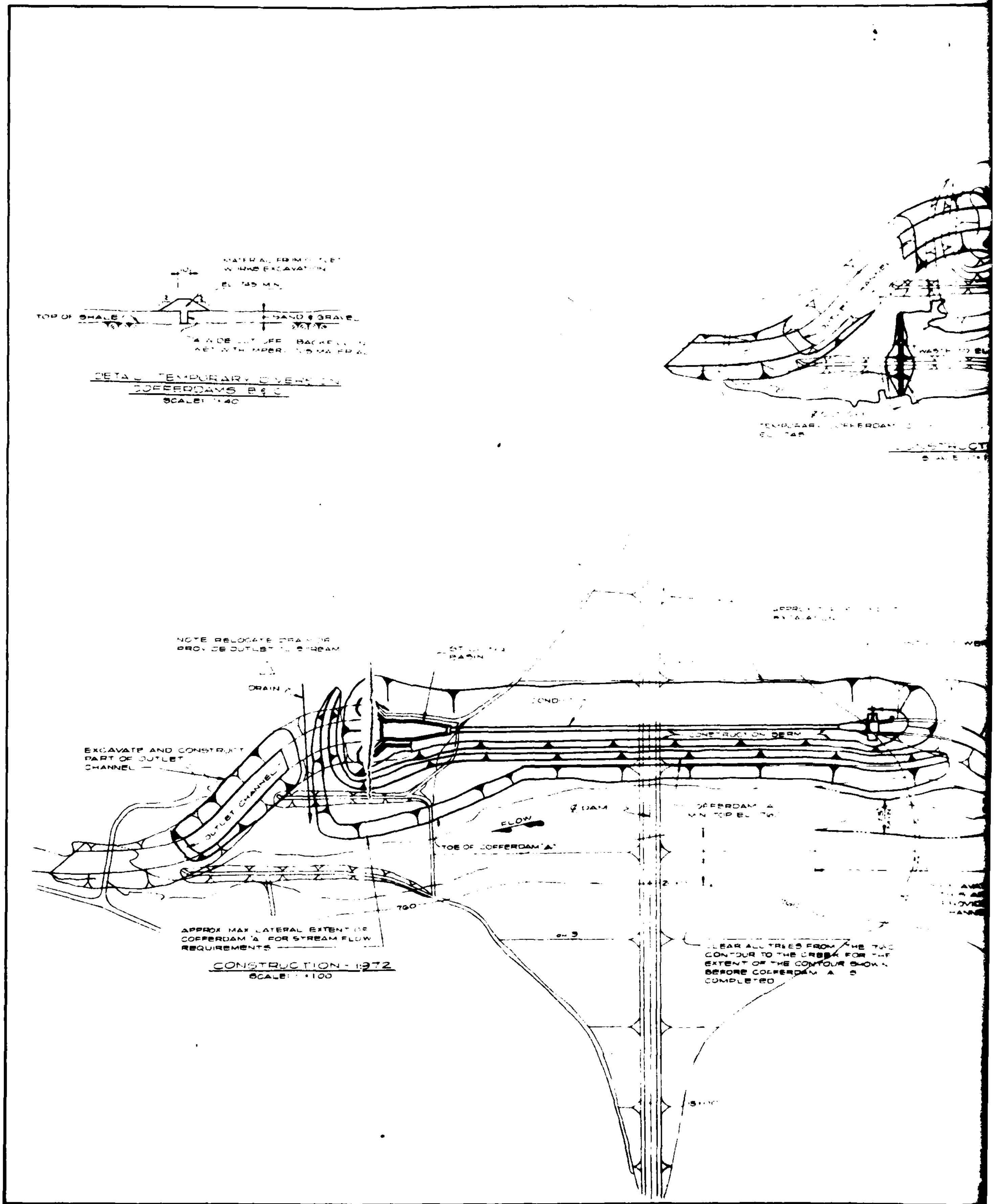
STABILITY ANALYSIS

FINITE SLICE METHOD

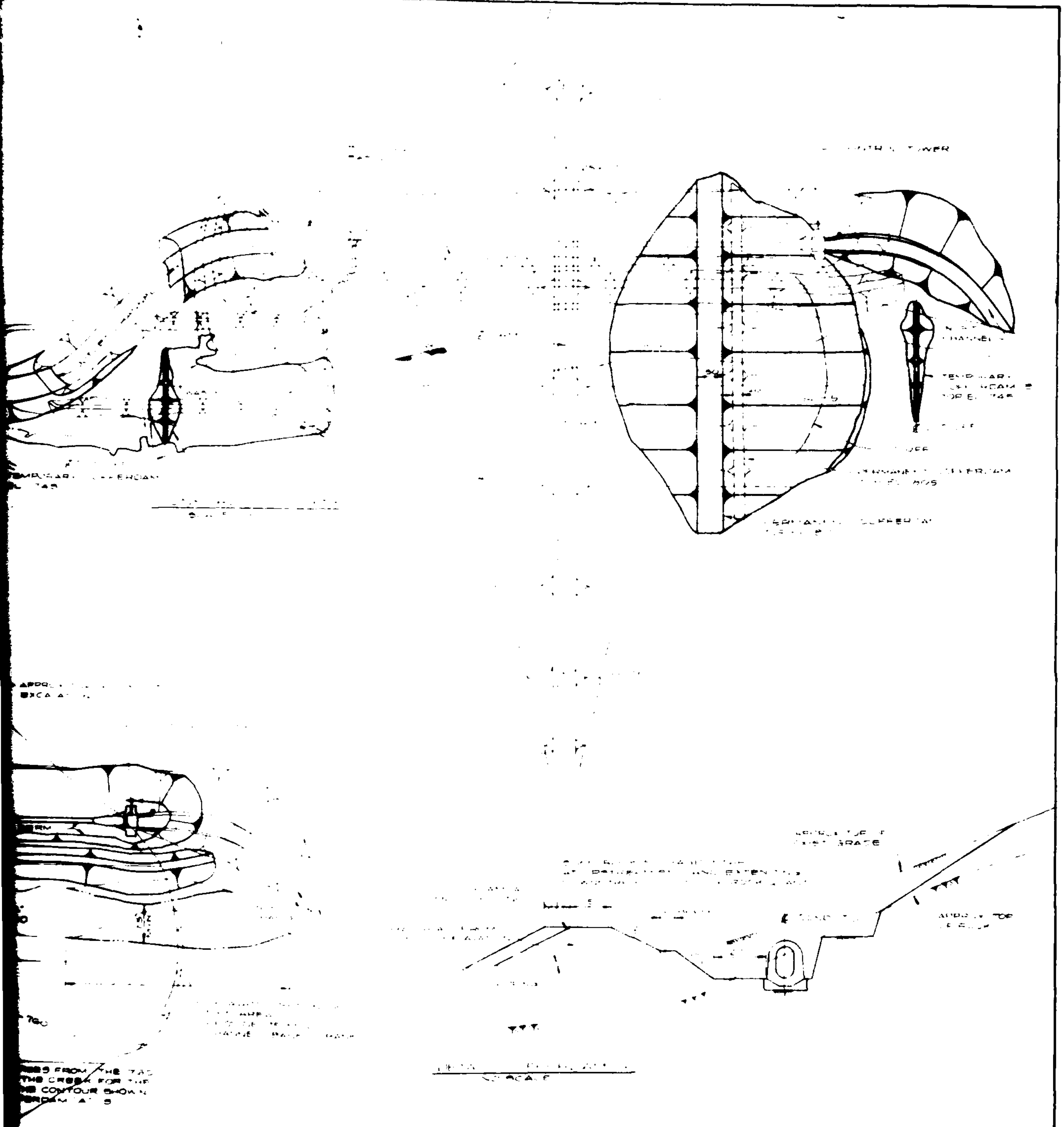
STEADY SEEPAGE

GVF OCT, 1969

CORPS OF ENGINEERS



U. S. ARMY




| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|
| 1 | | DRAINAGE PROVIDED FOR (AMDT NO 5) | JJB |
| | | SHEET ADDED (AMDT NO 3) | RDP |

U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE KENTUCKY

DESIGNED P.D.P. & G.M.
DRAWN
TRACED WH
CHECKED R.G.P.
SUBMITTED
SCALE

OHIO RIVER BASIN
CAESAR CREEK LAKE
LITTLE MIAMI RIVER
DAM
DIVERSION PLAN

DATE

DRAWING NUMBER
LM 52 - 12 3/1 A

PLATE 38

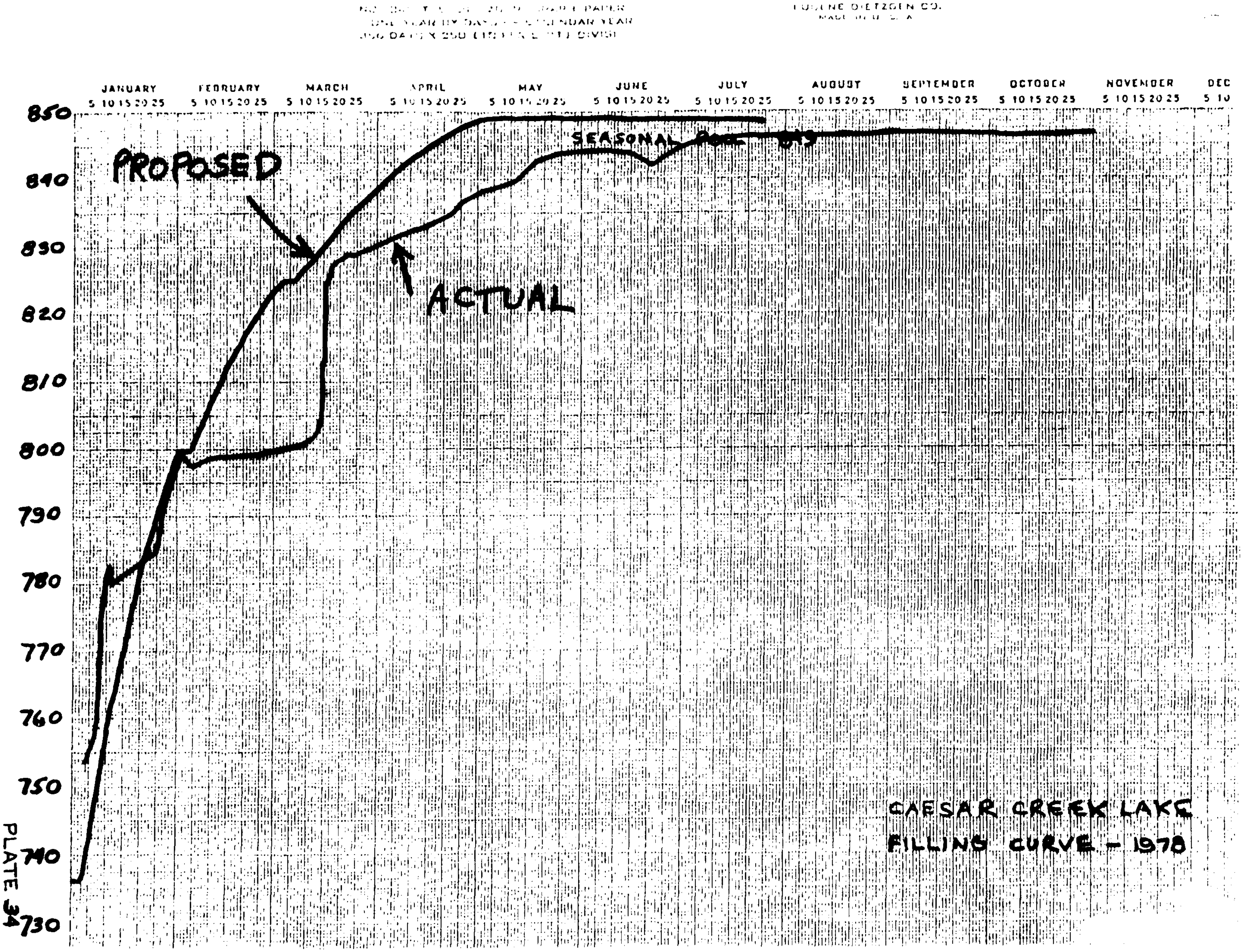
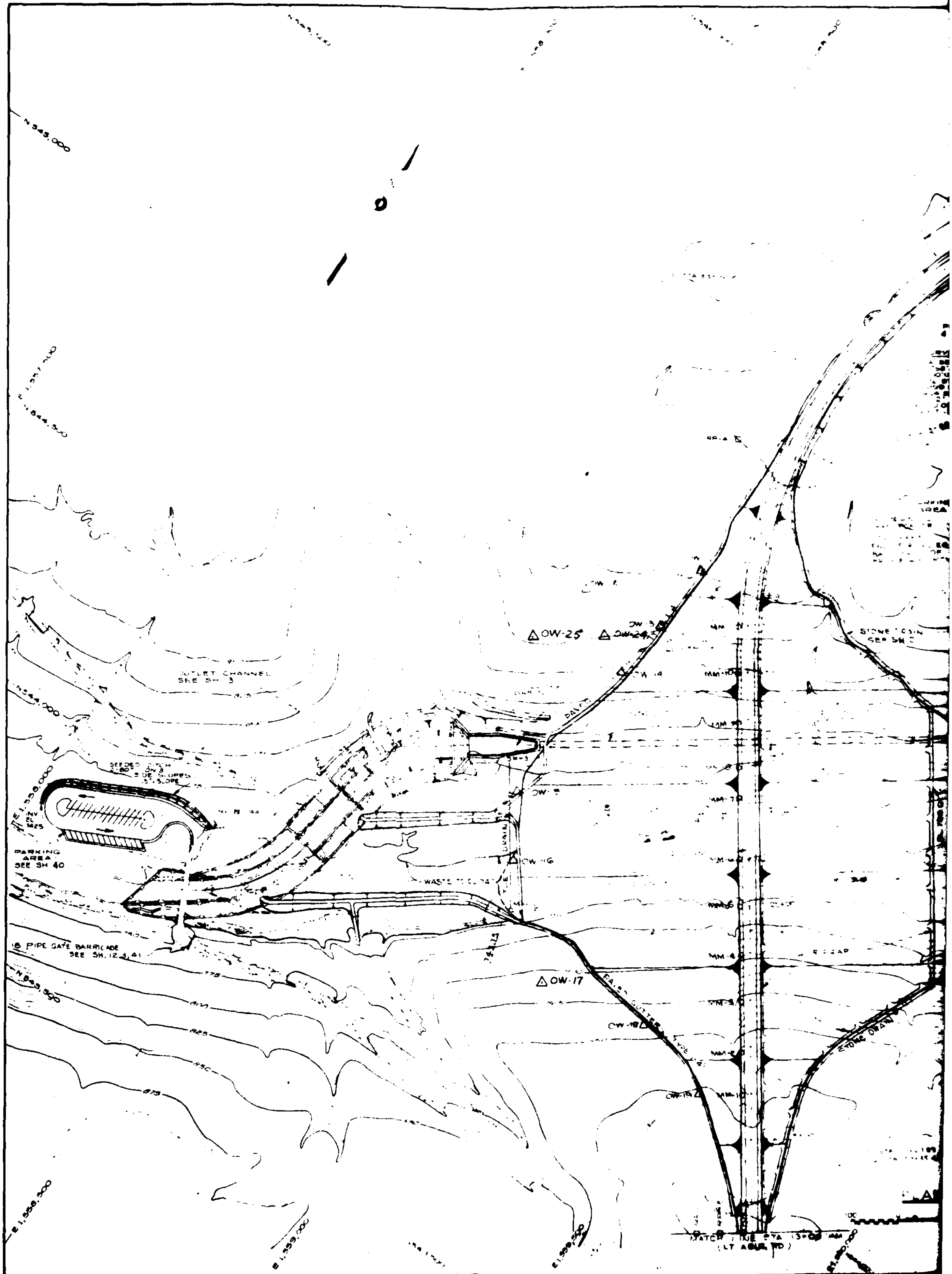
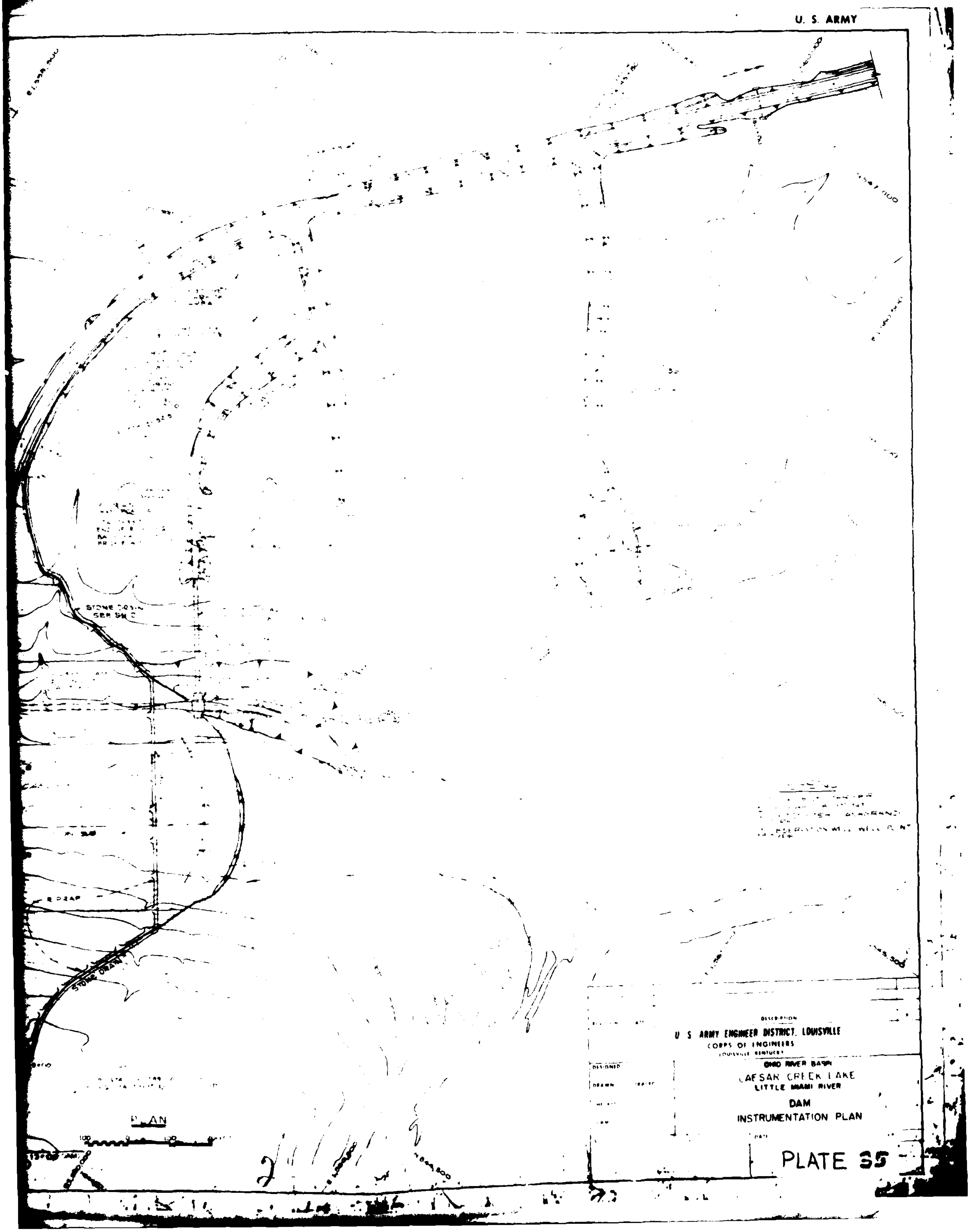

JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DEC
850
840
830
820
810
800
790
780
770
760
750
740
730
PROPOSED
ACTUAL
SEASONAL
CAESAR CREEK LAKE
FILLING CURVE - 1978
EUGENE DIETZGEN CO.

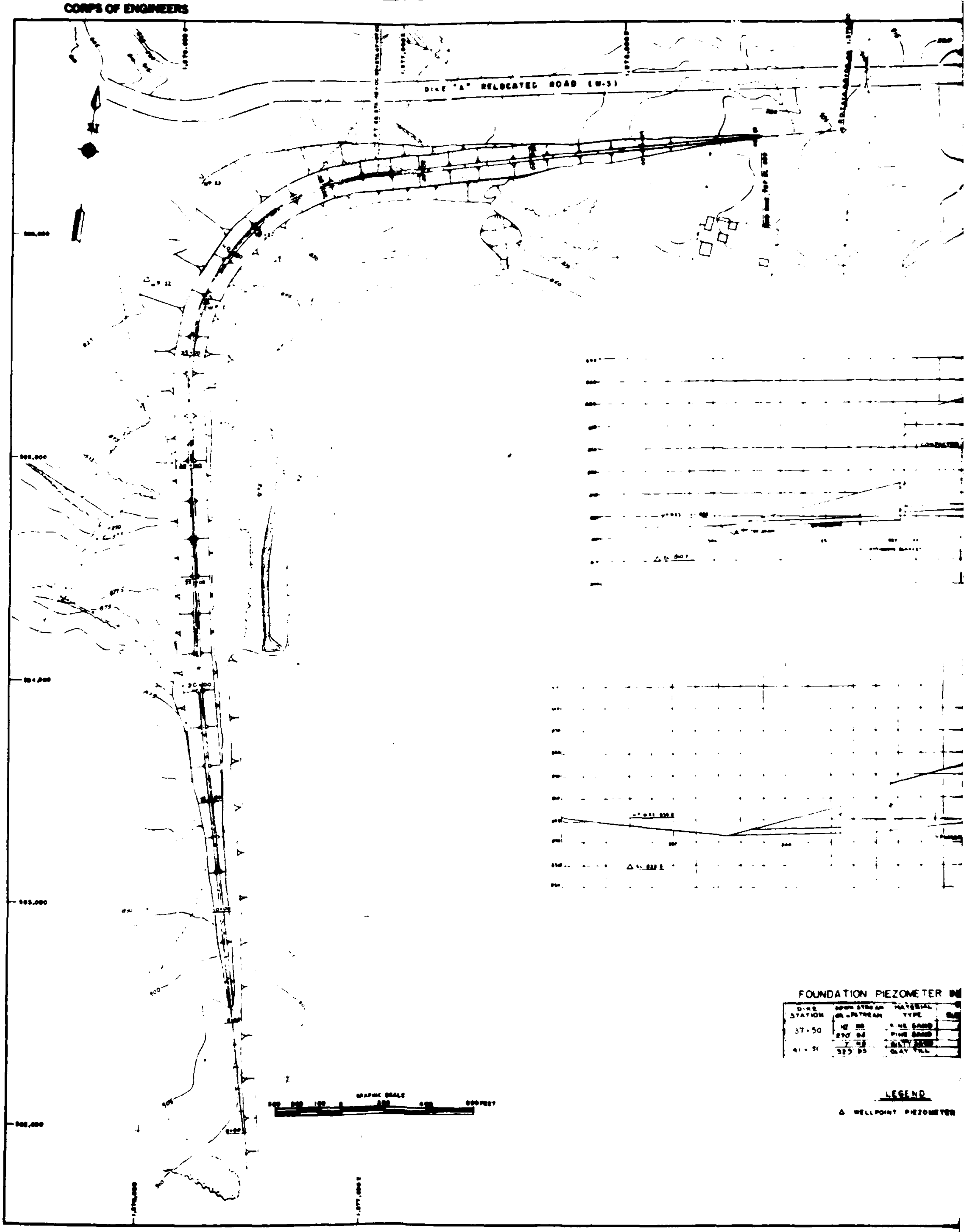
PLATE 34

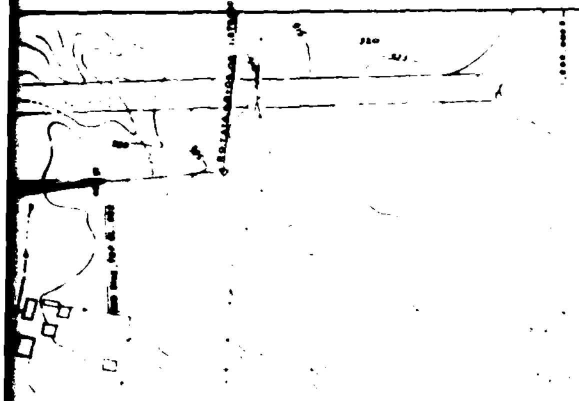

N 545,000
N 544,500
N 544,000
N 543,500
OUTLET CHANNEL
SEE SH. 3
SEEDED DITCH
PARKING
AREA
SEE SH 40
18 PIPE GATE BARRICADE
SEE SH. 12,3,41
OW-25
OW-17
OW-16
OW-14
OW-18
OW-19
STONE BASIN
SEE SH. 2
E 1,558,500
E 1,559,000
E 1,559,500
E 1,558,000
MATCH LINE STA 13+00
(LT ABUT. RD)
MM-10
MM-9
MM-8
MM-7
MM-6
MM-5
MM-4
MM-3
MM-2
MM-1
STONE DRAIN
WASTE

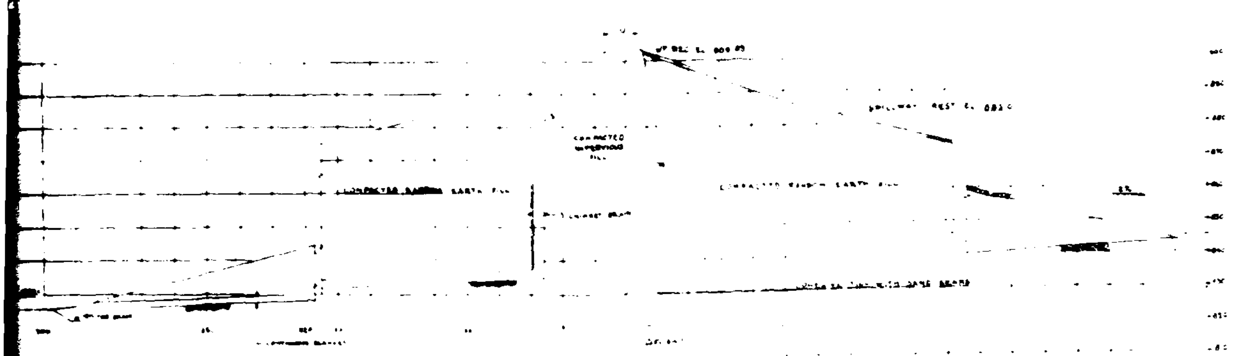


U. S. ARMY
STONE DRAIN
PLAN
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
OHIO RIVER BASIN
CAESAR CREEK LAKE
LITTLE MIAMI RIVER
DAM
INSTRUMENTATION PLAN
PLATE 35

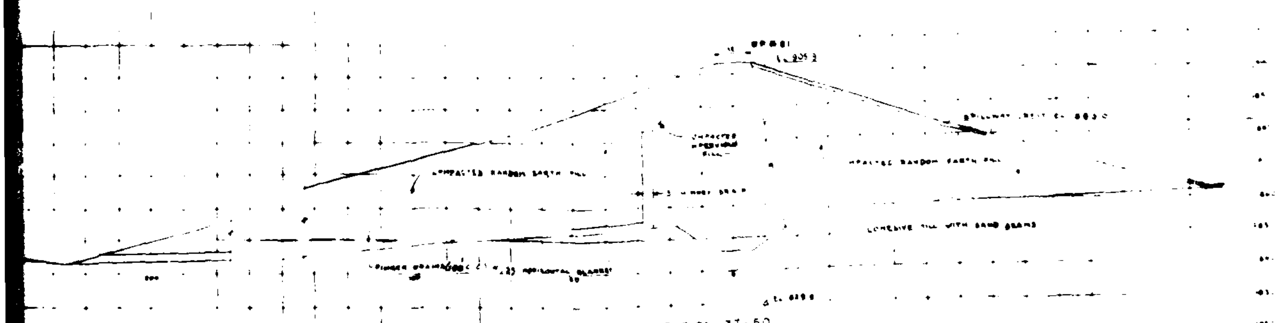
CORPS OF ENGINEERS







SECTION 41+50
Scales 1" = 20' H
1" = 20' V



SECTION 37+50
SCALE 1" = 20' Hor
1" = 20' Ver.

FOUNDATION PIEZOMETER INFORMATION

| DIKE STATION | DOWN STREAM OR UPSTREAM | MATERIAL TYPE | ELEVATION | NUMBER |
|---|---|---|---|---|
| 37+50 | [illegible] | FINE SAND | [illegible] | WP-21 |
| | 270' DS | FINE SAND | [illegible] | WP-22 |
| 41+50 | [illegible] | SILTY SAND | [illegible] | WP-22 |
| | 325' DS | CLAY TILL | 810.7 | WP-23 |

LEGEND

△ WELLPOINT PIEZOMETER

2

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|
| NO. TWO | 29 12 77 | NAME OF NEW ROAD, RECTIFICATION OF THE COORD SYSTEM | |

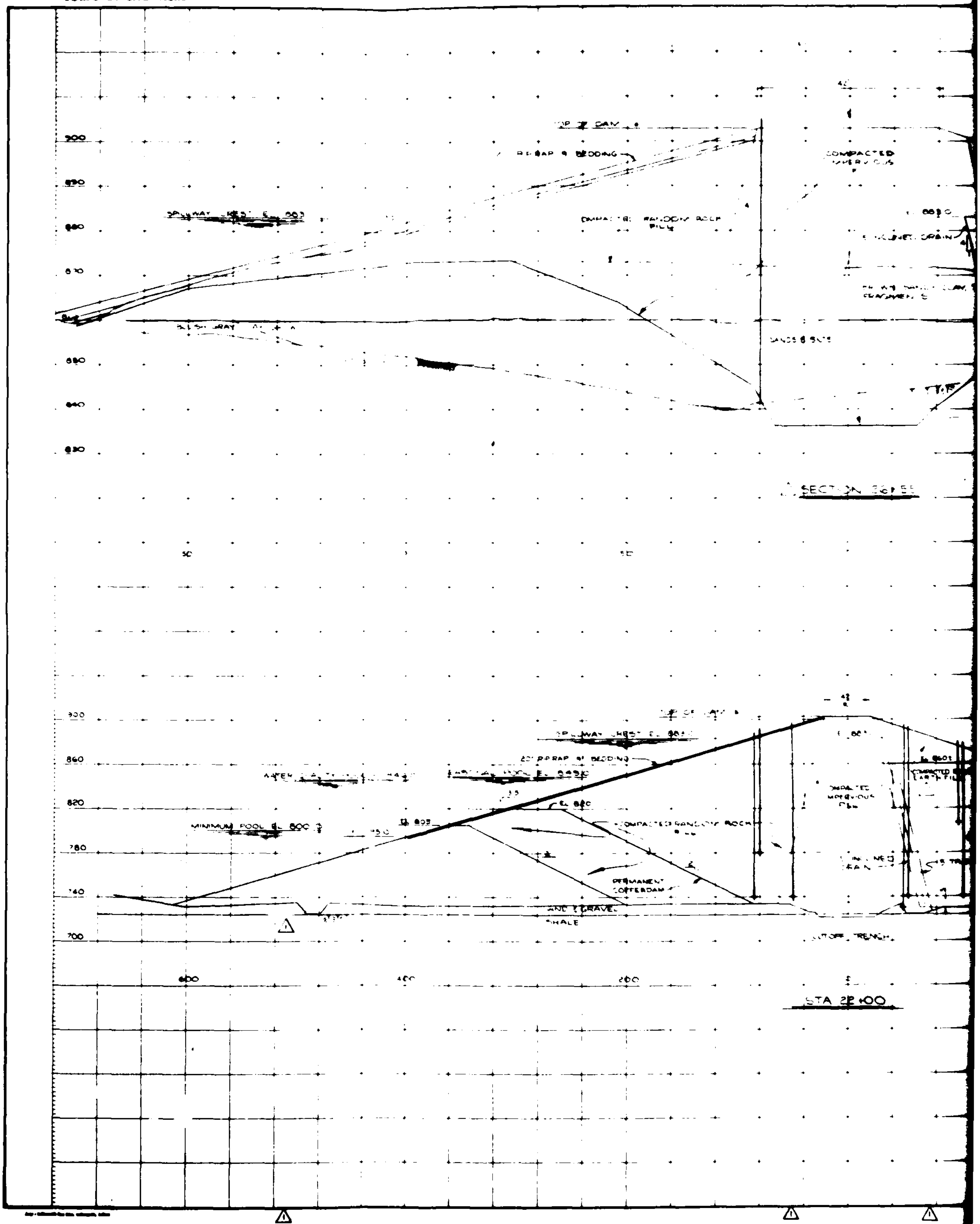
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

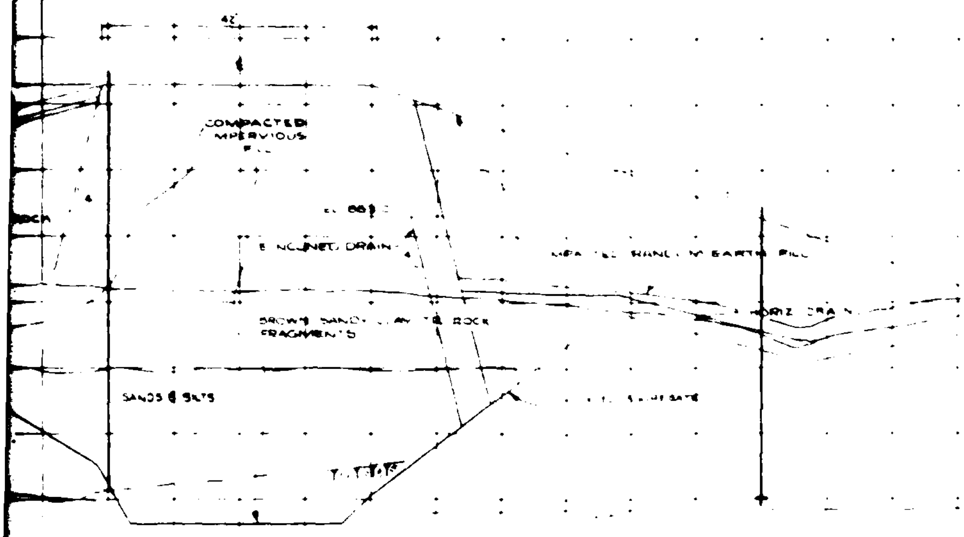
OHIO RIVER BASIN
CAESAR CREEK RESERVOIR
LITTLE MIAMI RIVER
DIKE "A"
INSTRUMENTATION PLAN & SECTIONS

DESIGNED:
DRAWN:
TRACED: B.H.S.
CHECKED: BY ENGINEER & SURVEY
SUBMITTED:
SCALE: AS SHOWN
DATE:
DRAWING NUMBER

PLATE 36

CORPS OF ENGINEERS






SECTION 26+55

## MOVEMENT MONUMENT INFORMATION

| DAM STATION | DOWNSTREAM LOCATION | IDENTIFICATION SEE PLAN |
|---|---|---|
| [illegible]+00 | 20 DS | R-3 |
| 1[illegible]+00 | 70 DS | R-2 |
| 13+00 | 120 DS | R-1 |
| [illegible] | 20 DS | M-[illegible] |
| [illegible] | 20 DS | M-[illegible] |
| [illegible] | 20 DS | M-3 |
| [illegible] | 20 DS | M-4 |
| [illegible] | 20 DS | M-[illegible] |
| [illegible] | 20 DS | M-[illegible] |
| [illegible] | 20 DS | M-[illegible] |
| [illegible] | 20 DS | M-[illegible] |
| [illegible] | 20 DS | M-9 |
| [illegible] | 20 DS | M-[illegible] |
| [illegible] | 20 DS | M-[illegible] |
| 29+99.[illegible] | 40 DS | R-4 |

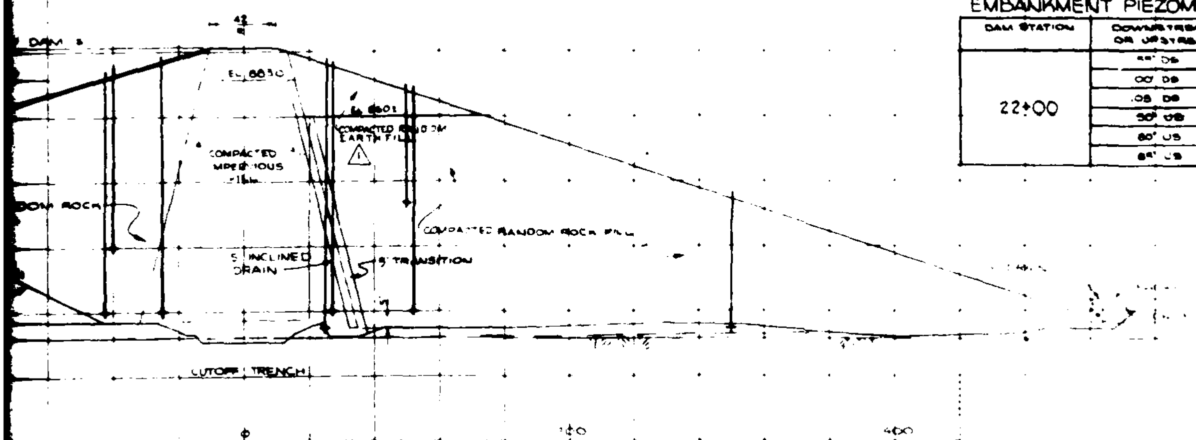
R = REFERENCE MONUMENT
M = MOVEMENT MONUMENT

## FOUNDATION PIEZOMETER INFORMATION

| DAM STATION | DOWNSTREAM OR UPSTREAM | MATERIAL TYPE | TIP ELEVATION |
|---|---|---|---|
| 22+00 | 50' DS | SAND & GRAVEL | [illegible] |
| [illegible]+95 | 100' DS | SAND & GRAVEL | 728.[illegible] |
| 26+55 | 80' DS | [illegible] | [illegible] |
| | 30' US | [illegible] | [illegible] |

## EMBANKMENT PIEZOMETER INFORMATION

| DAM STATION | DOWNSTREAM OR UPSTREAM | TIP ELEVATION |
|---|---|---|
| 22+00 | [illegible]' DS | 740.0 |
| | [illegible]00' DS | 807.0 |
| | [illegible]05' DS | [illegible] |
| | 30' DS | 760.0 |
| | 80' US | 780.0 |
| | 85' US | 740.0 |




STA 22+00

LEGEND
+ PIEZOMETER (CASAGRANDE TYPE)

THIS DRAWING REFLECTS "AS CONSTRUCTED" CONDITIONS

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|
| 1 | [illegible] | SECTION [illegible] NOTE REVISED AMDT NO 3 | [illegible] |

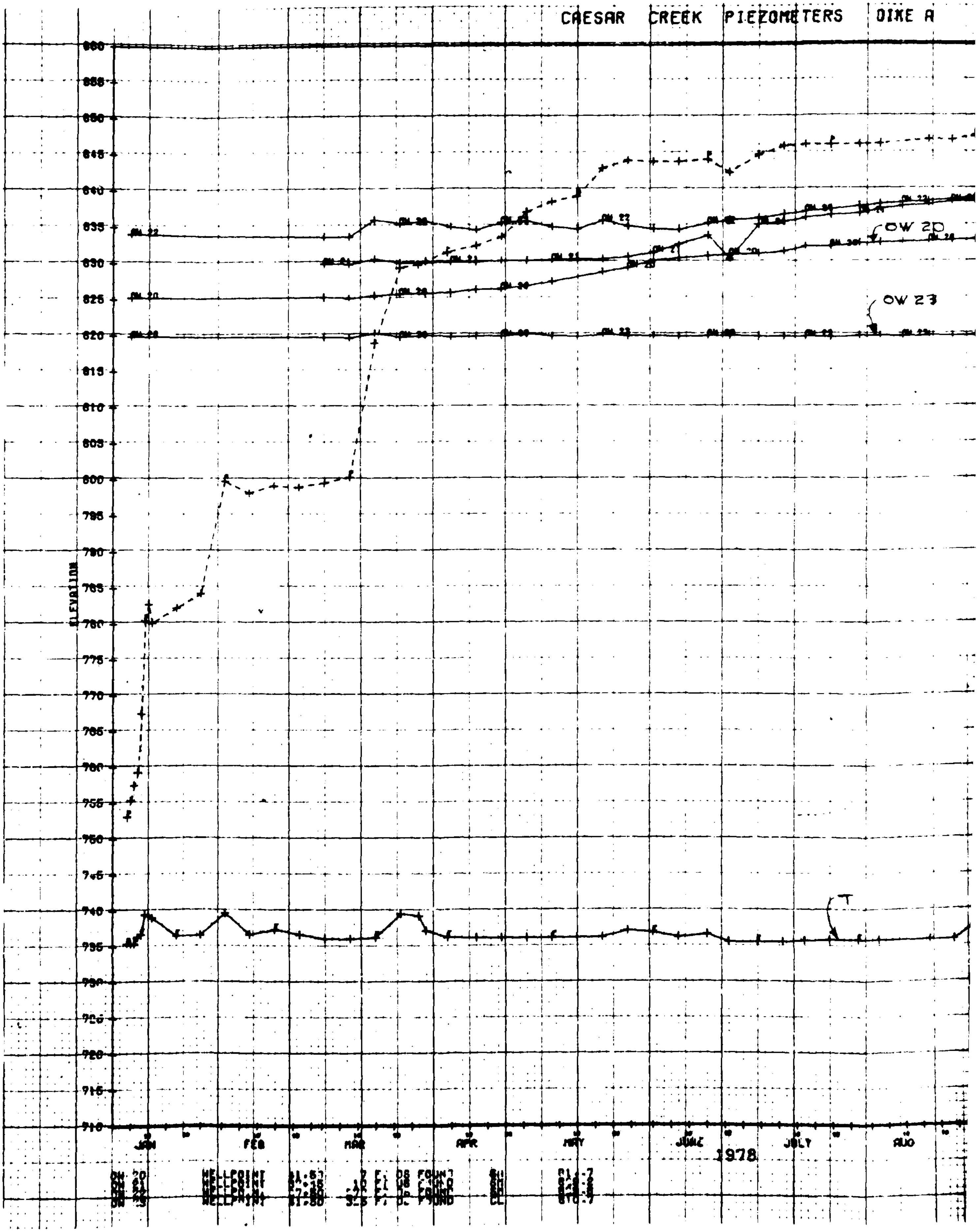
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
CAESAR CREEK LAKE
LITTLE MIAMI RIVER
DAM
INSTRUMENTATION - SECTIONS

DESIGNED
DRAWN W W M S TRACED [illegible]
CHECKED
SUBMITTED
SCALE
DATE
DRAWING NUMBER



2


CAESAR CREEK PIEZOMETERS DIKE A
ELEVATION
860
855
850
845
840
835
830
825
820
815
810
805
800
795
790
785
780
775
770
765
760
755
750
745
740
735
730
725
720
715
710
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
1978
OW 20
OW 23
T

CAESAR CREEK PIEZOMETERS DIKE A

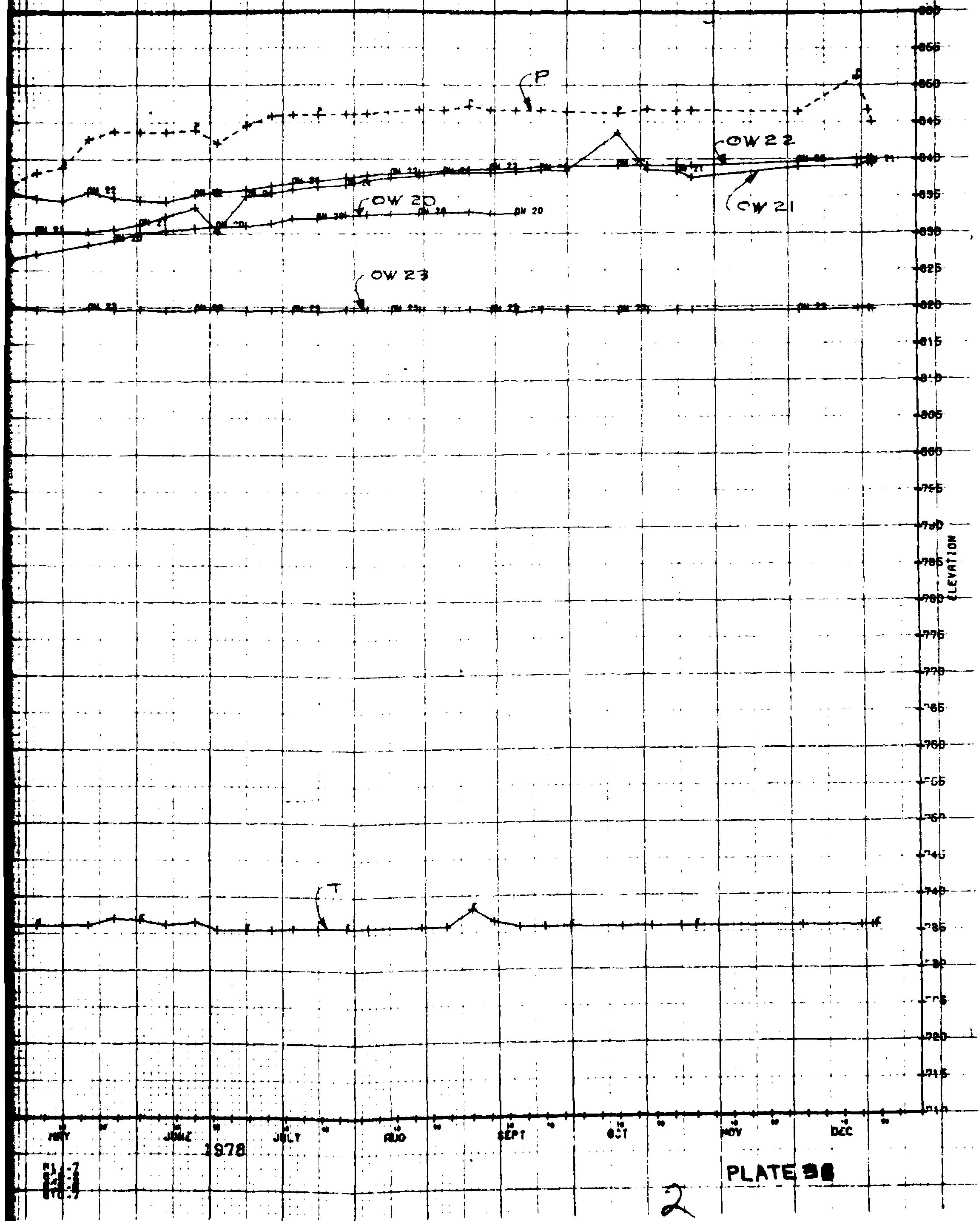
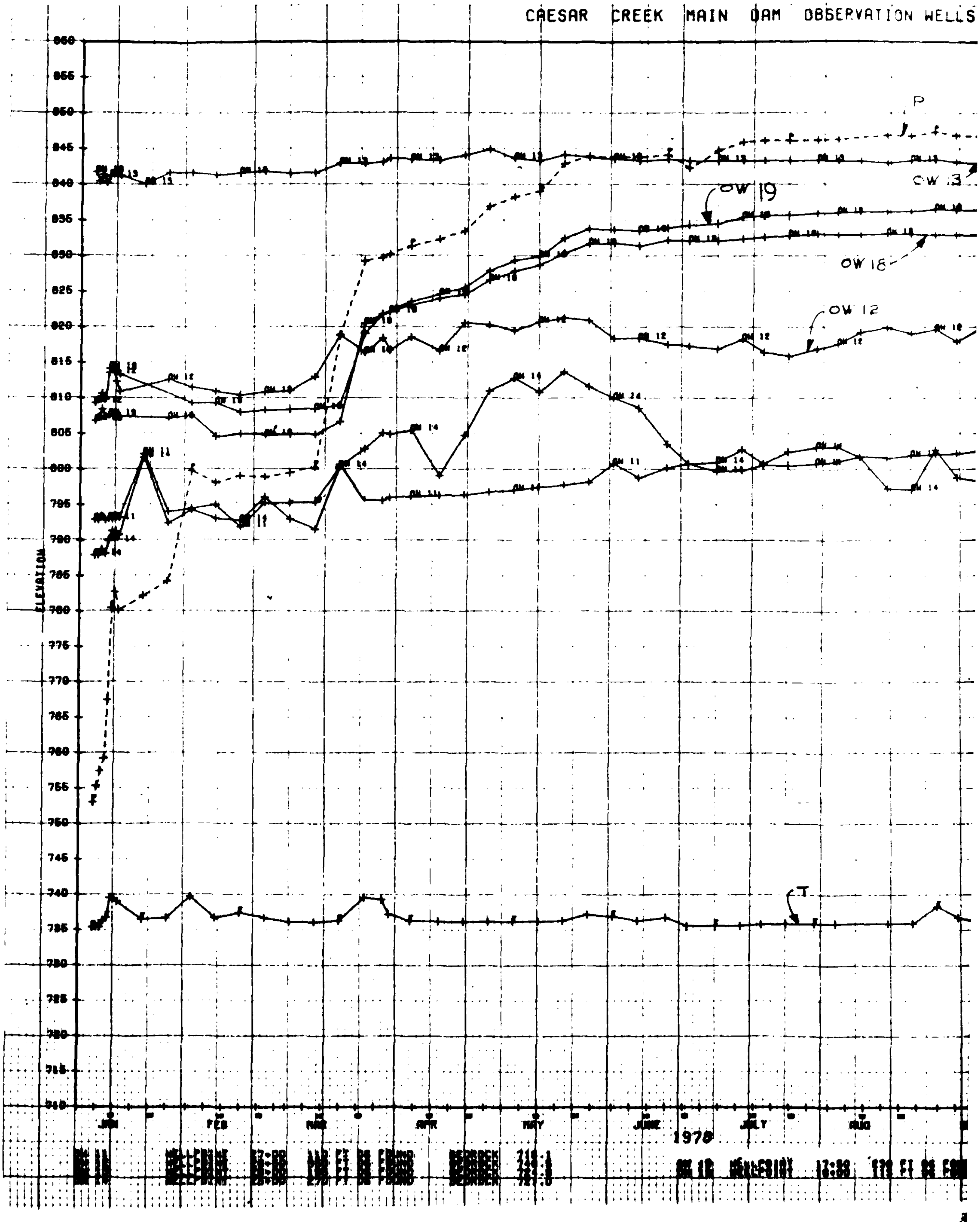



PLATE 58



CAESAR CREEK MAIN DAM OBSERVATION WELLS
ELEVATION
OW 19
OW 18
OW 12
OW 13
P
T
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
1978

CAESAR CREEK MAIN DAM OBSERVATION WELLS

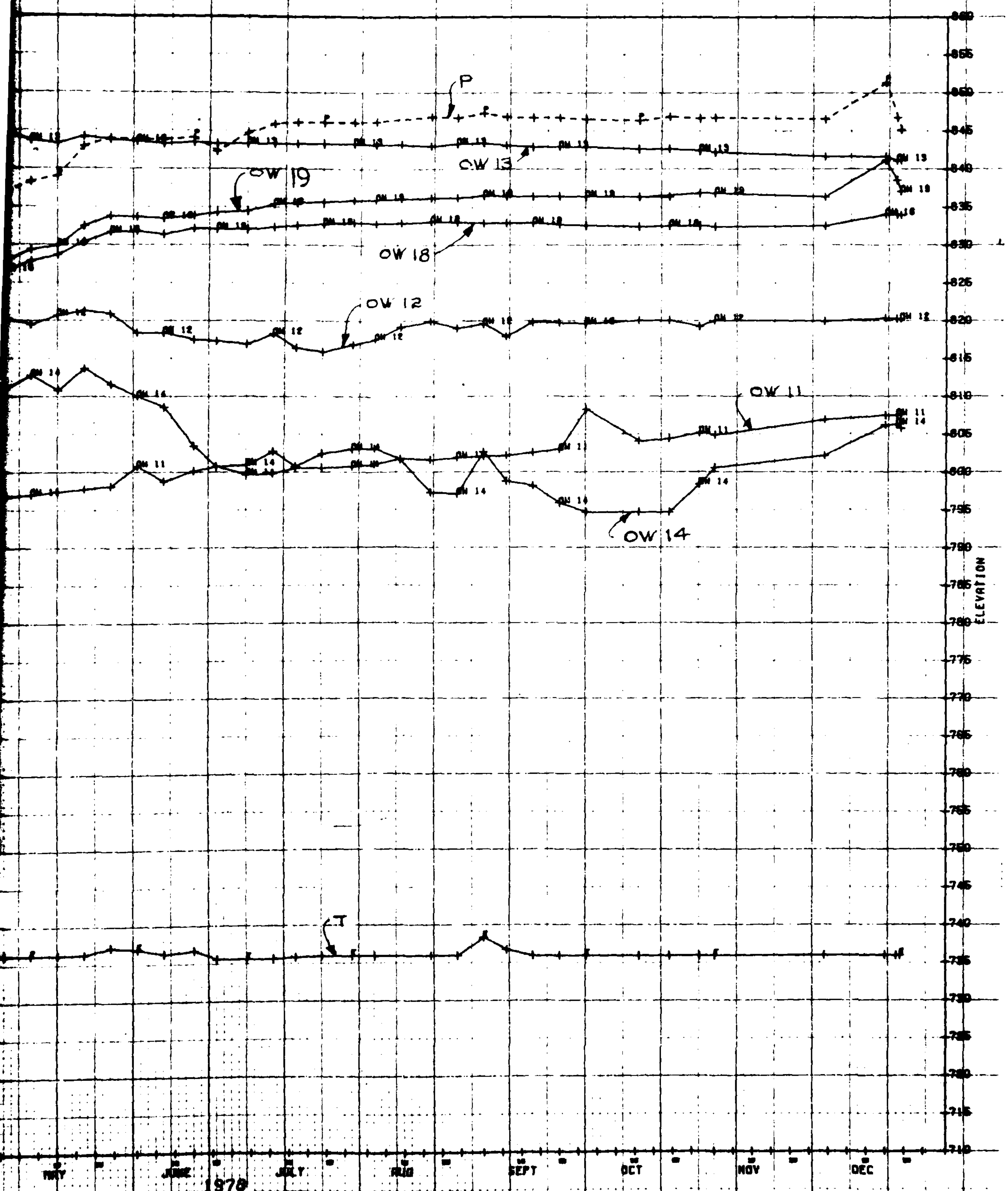
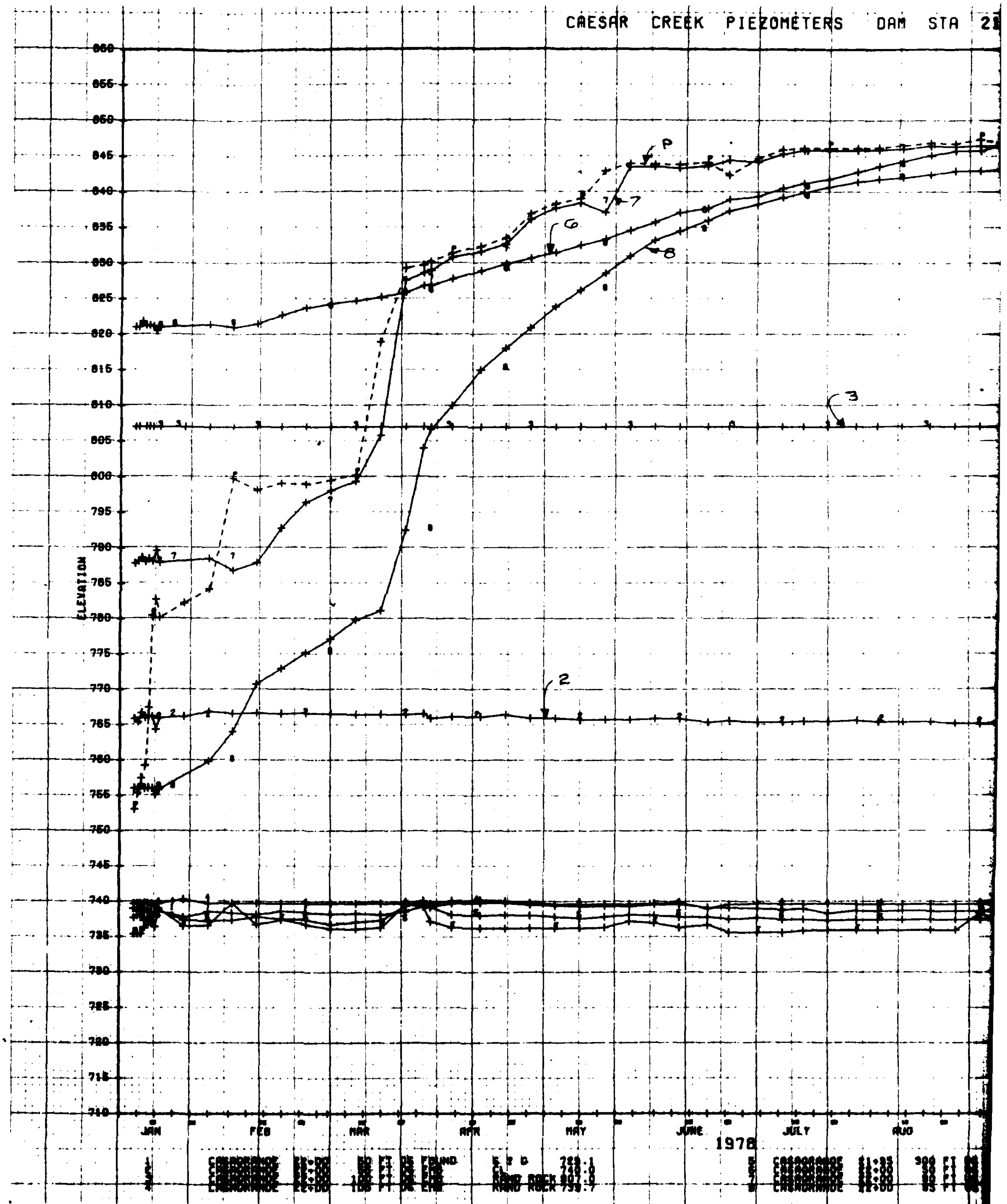



PLATE 39



CAESAR CREEK PIEZOMETERS DAM STA 2
ELEVATION
860
855
850
845
840
835
830
825
820
815
810
805
800
795
790
785
780
775
770
765
760
755
750
745
740
735
730
725
720
715
710
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
1978
P
7
6
8
3
2
1 CASAGRANDE FT DS FOUND 729.1
2 CASAGRANDE FT DS EMB CL 740.0
3 CASAGRANDE 100 FT DS EMB RAND ROCK 807.0
4 CASAGRANDE 22+00 100 FT DS EMB RAND ROCK 739.7
5 CASAGRANDE 300 FT
6 CASAGRANDE FT
7 CASAGRANDE FT
8 CASAGRANDE FT

CAESAR CREEK PIEZOMETERS DAM STA 21+95 TO 22+00

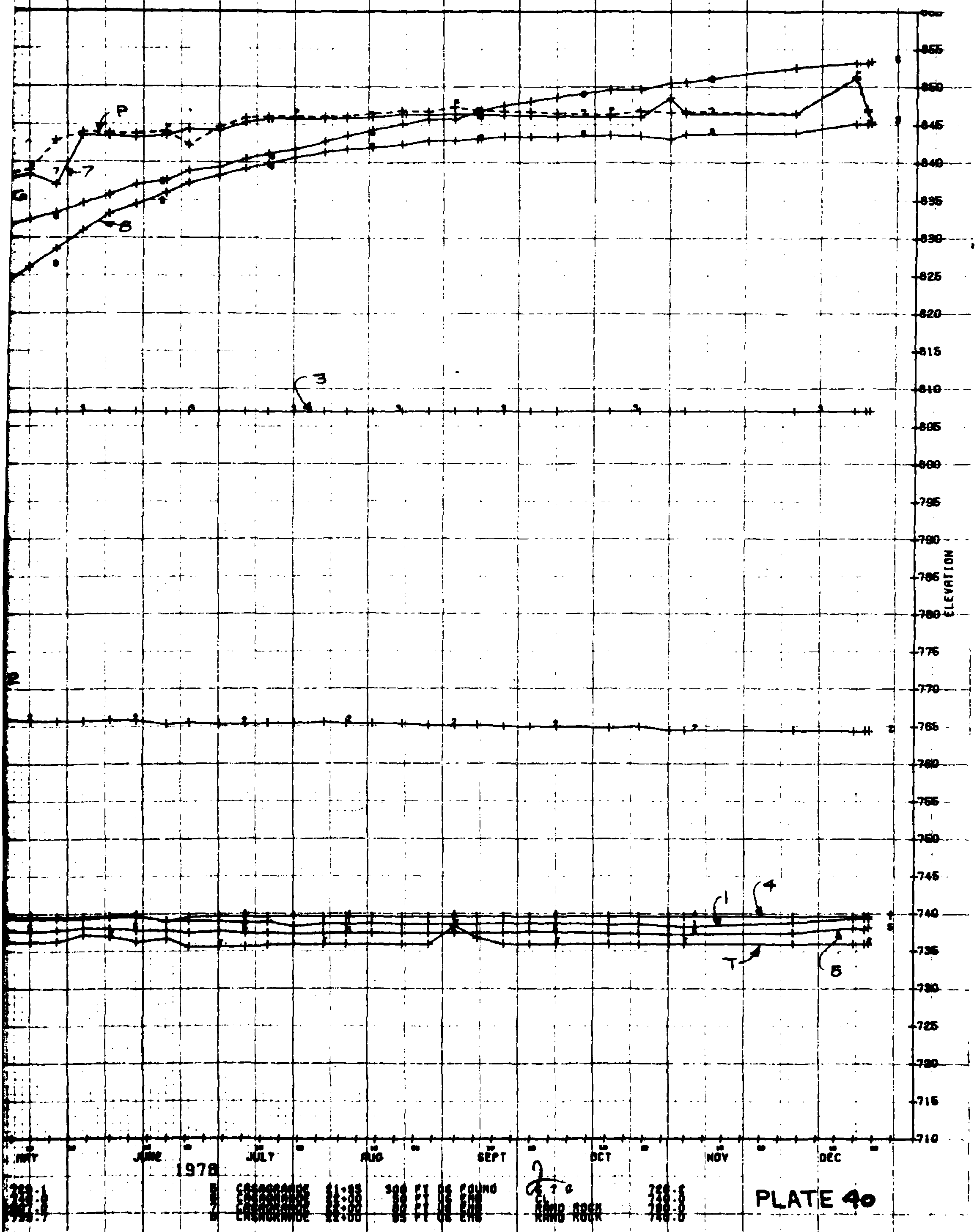
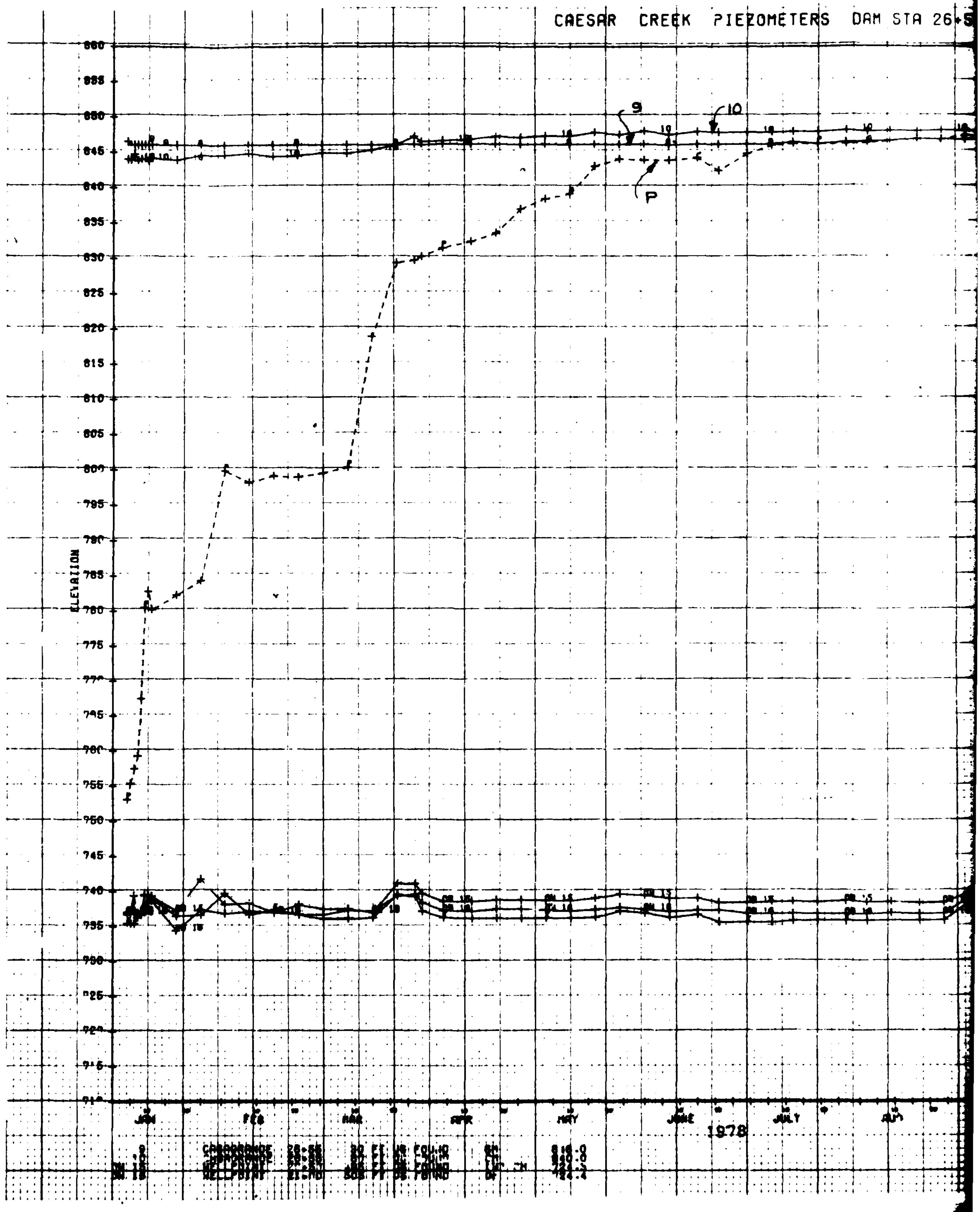
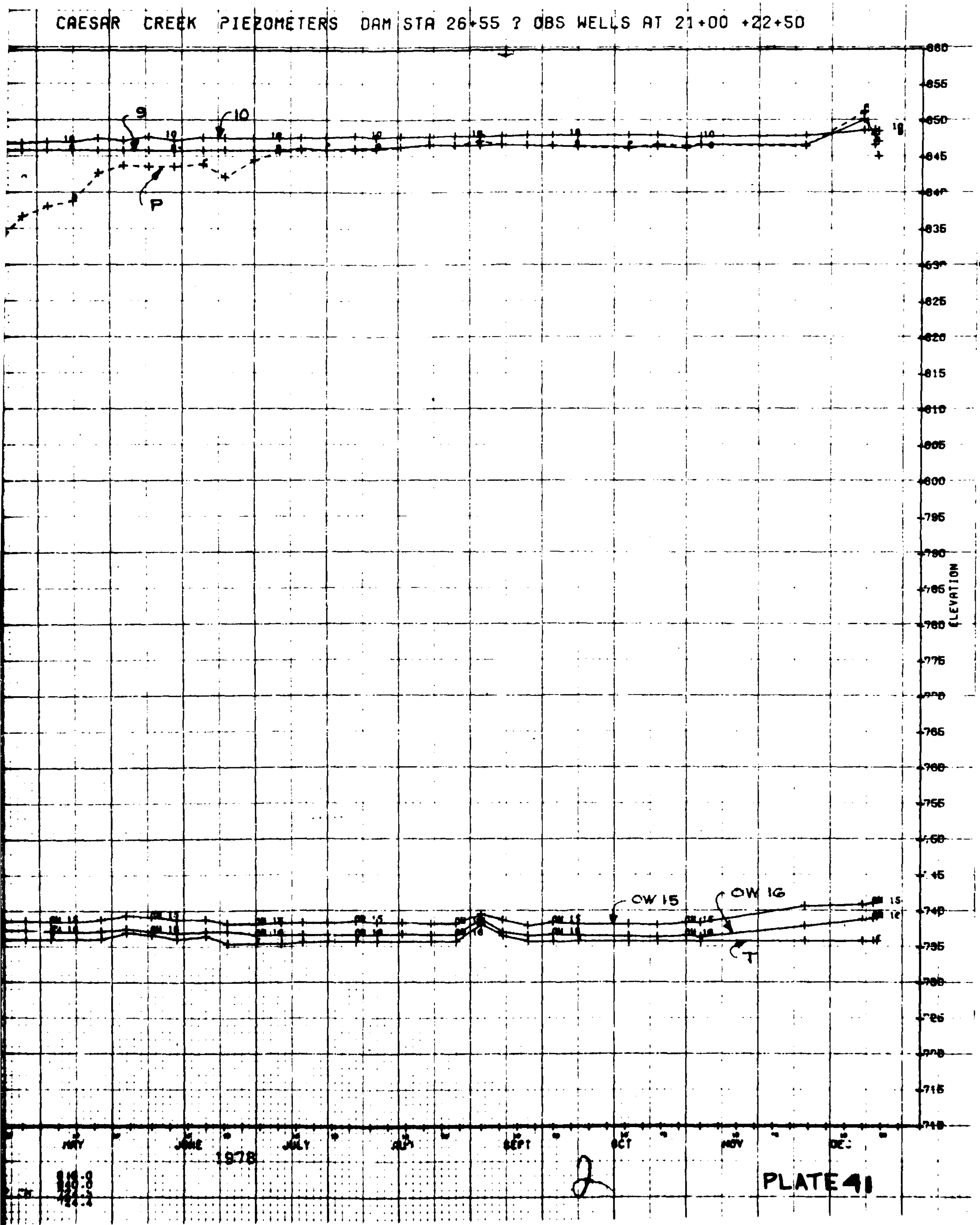


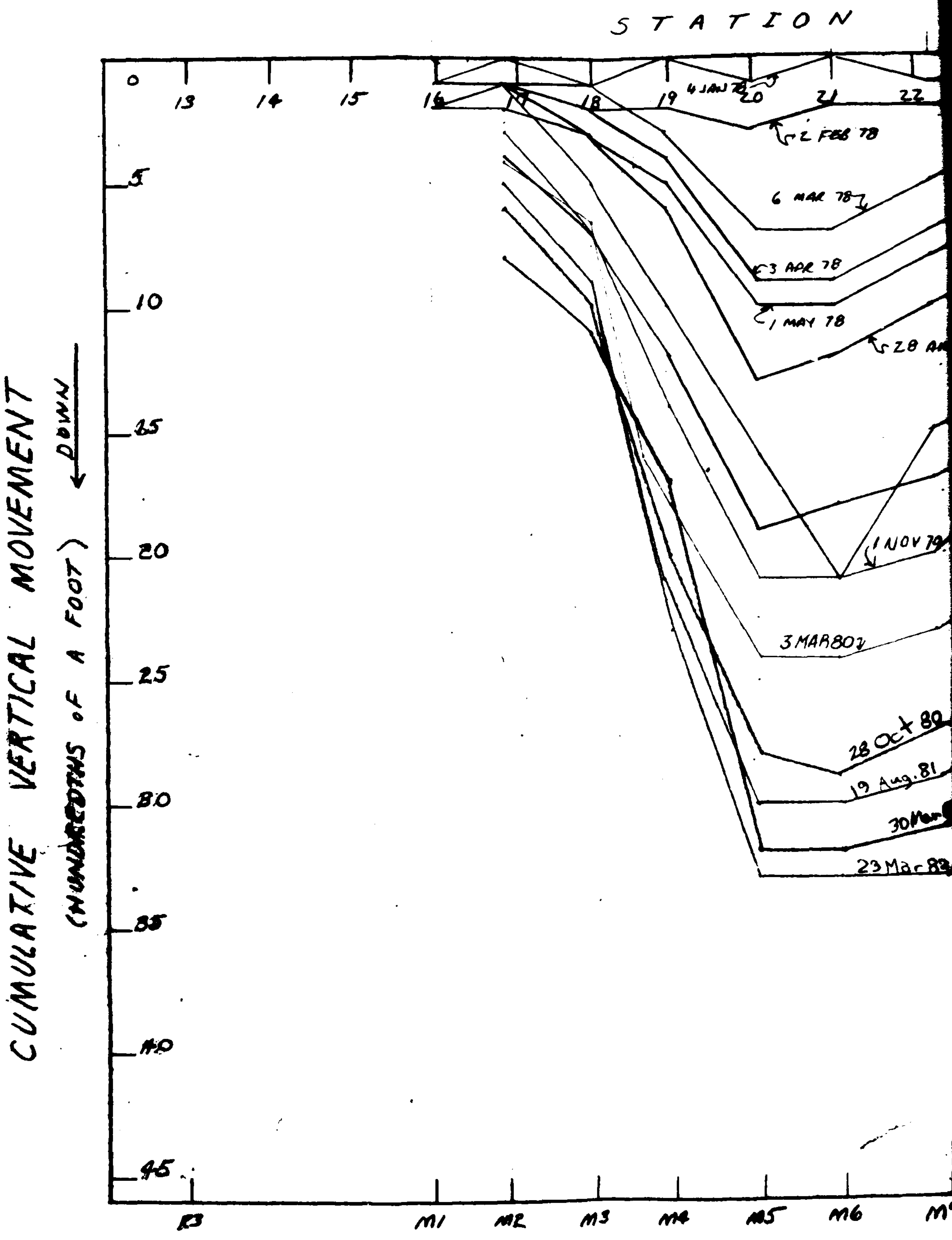

PLATE 40



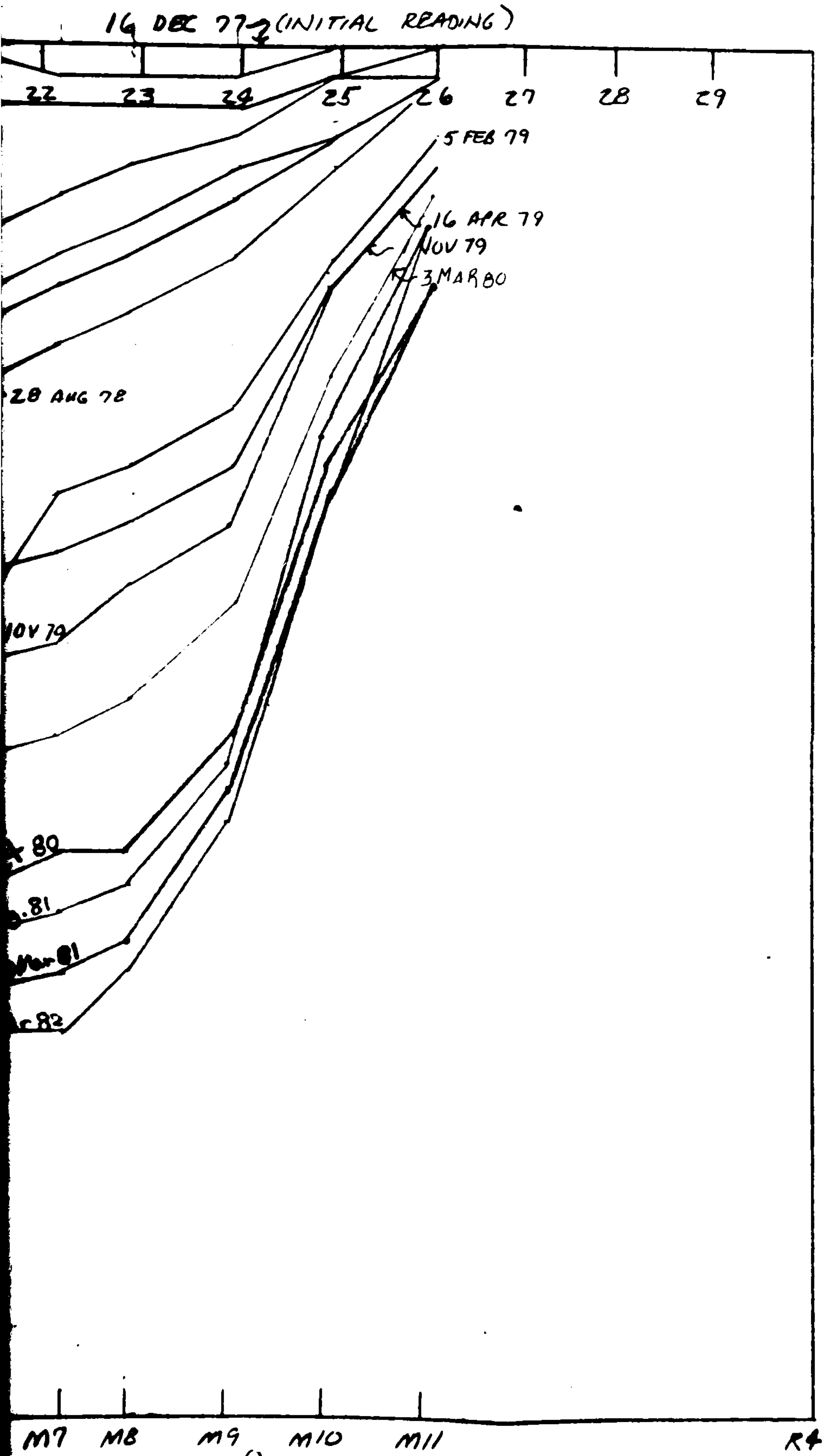
CAESAR CREEK PIEZOMETERS DAM STA 26+5
ELEVATION
860
855
850
845
840
835
830
825
820
815
810
805
795
785
780
775
745
740
735
9
10
P
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
1978



CAESAR CREEK PIEZOMETERS DAM STA 26+55 ? OBS WELLS AT 21+00 +22+50
9
10
P
OW 15
OW 16
T
ELEVATION
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1978
PLATE 41



STATION
CUMULATIVE VERTICAL MOVEMENT
(HUNDREDTHS OF A FOOT)
DOWN
0
5
10
15
20
25
30
35
40
45
13
14
15
16
17
18
19
20
21
22
4 JAN 78
2 FEB 78
6 MAR 78
3 APR 78
1 MAY 78
28 A
1 NOV 79
3 MAR 80
28 Oct 80
19 Aug. 81
30 Mar
23 Mar 83
E3
M1
M2
M3
M4
M5
M6
M




# CAESAR CREEK

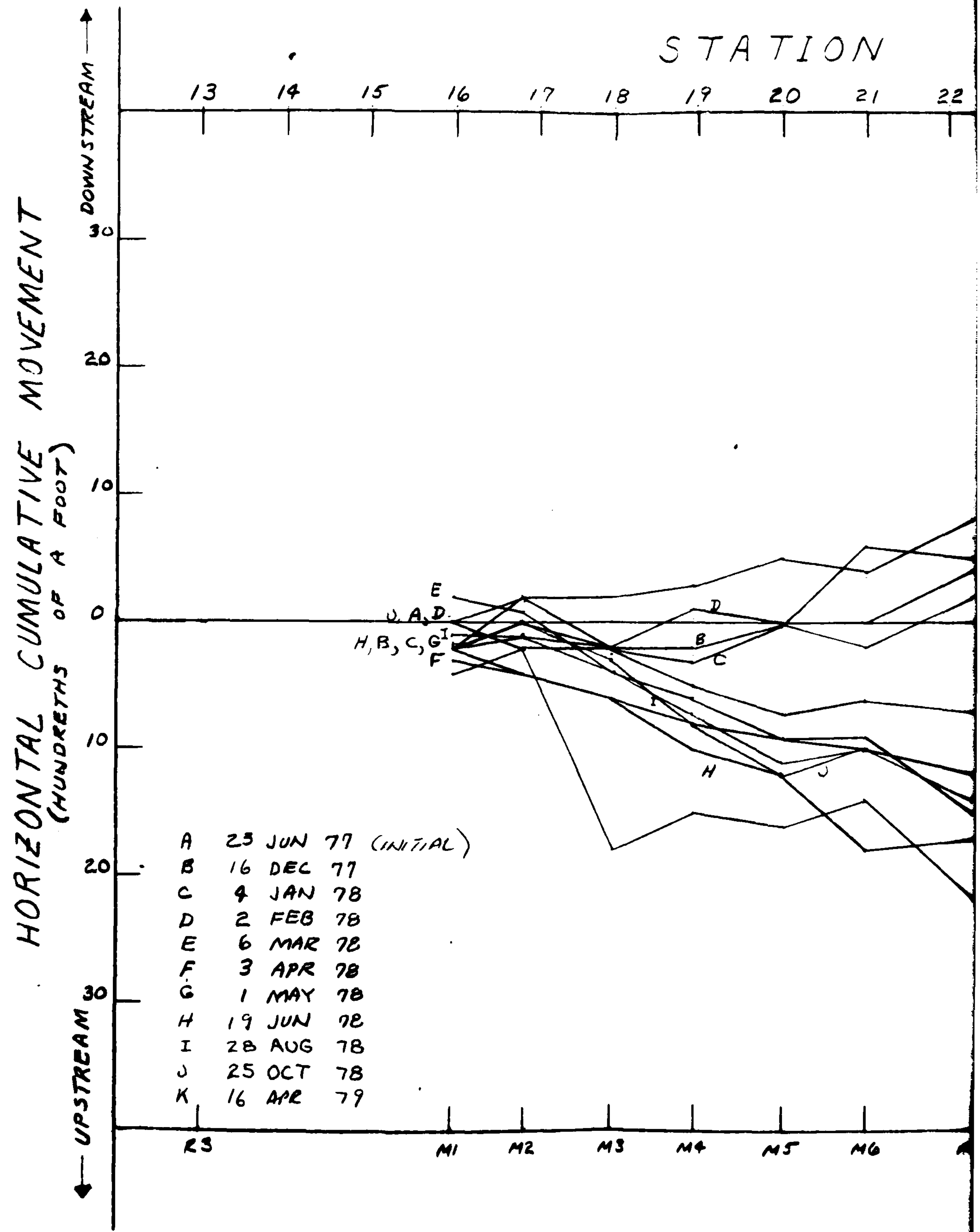
## MOVEMENT MARKERS

## 20' D.S. ℄

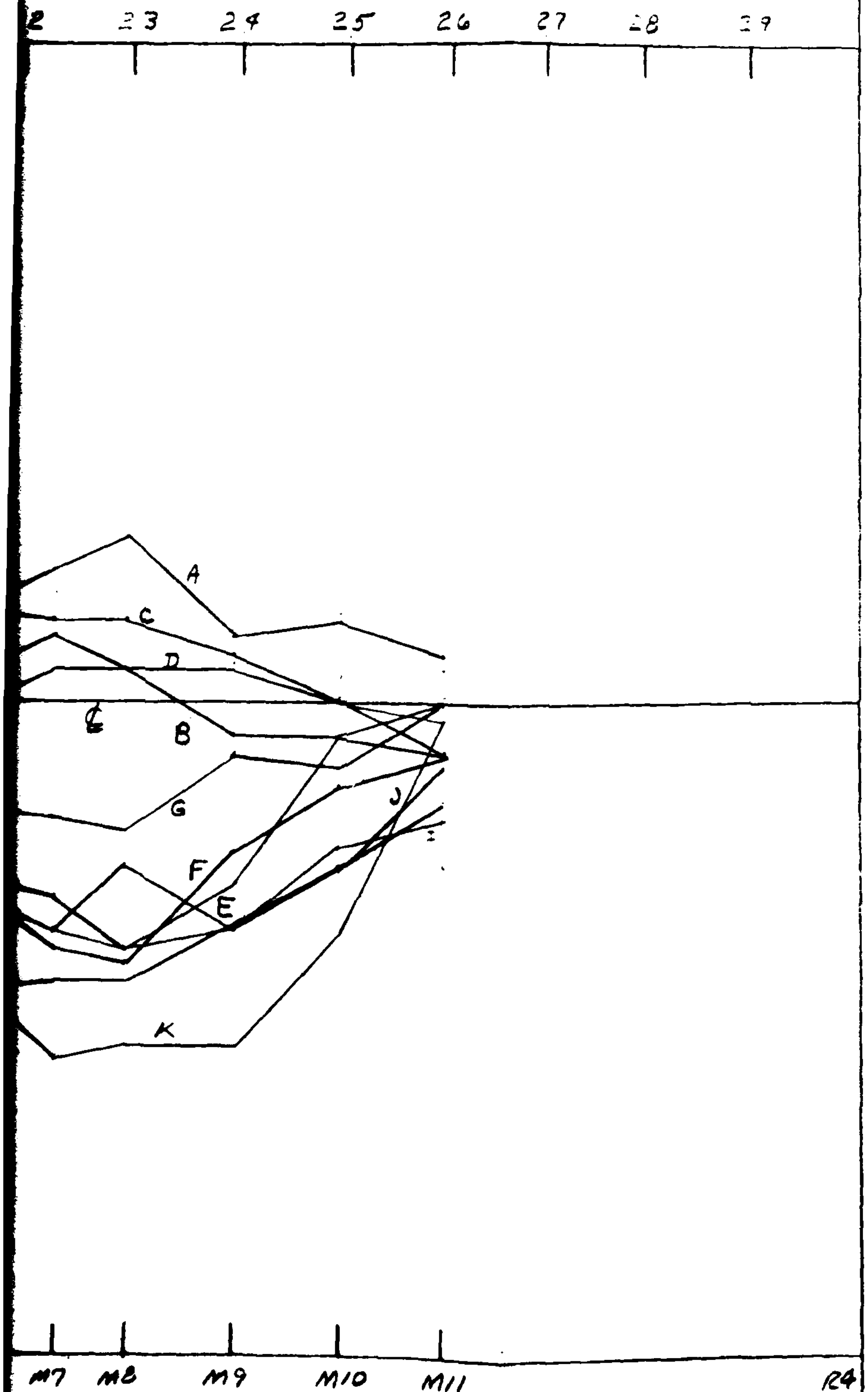
## VERTICAL MOVEMENT

| MOVEMENT MARKERS | INITIAL READINGS |
|---|---|
| M-1 | 902.74 |
| M-2 | 902.48 |
| M-3 | 902.53 |
| M-4 | 902.37 |
| M-5 | 901.98 |
| M-6 | 901.90 |
| M-7 | 901.91 |
| M-8 | 902.04 |
| M-9 | 902.59 |
| M-10 | 903.28 |
| M-11 | 903.84 |

PLATE 42



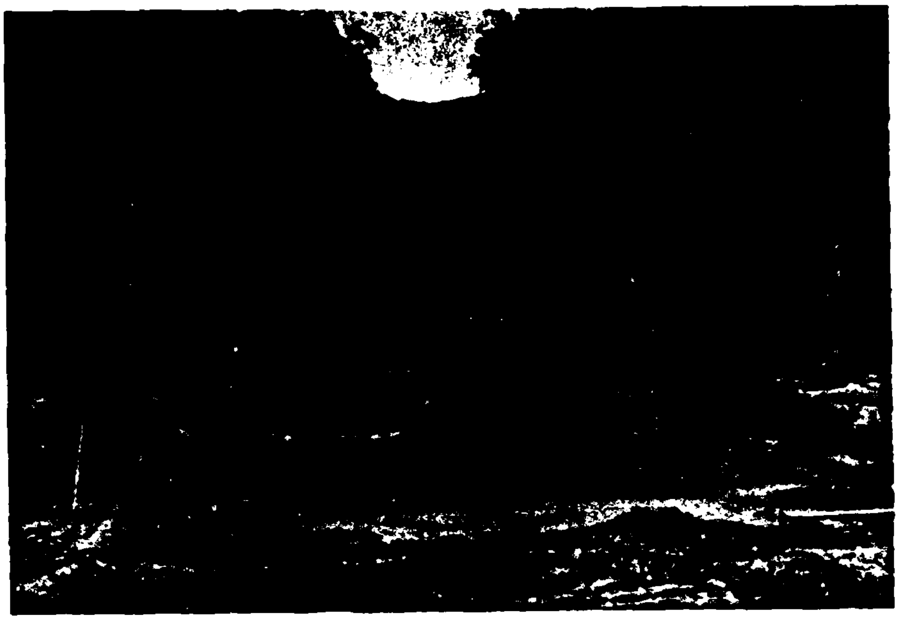
STATION
13 14 15 16 17 18 19 20 21 22
HORIZONTAL CUMULATIVE MOVEMENT
(HUNDRETHS OF A FOOT)
DOWNSTREAM
UPSTREAM
30
20
10
0
10
20
30
E
J, A, D
H, B, C, G I
F
D
B
C
I
H
J
A 25 JUN 77 (INITIAL)
B 16 DEC 77
C 4 JAN 78
D 2 FEB 78
E 6 MAR 78
F 3 APR 78
G 1 MAY 78
H 19 JUN 78
I 28 AUG 78
J 25 OCT 78
K 16 APR 79
RS
M1 M2 M3 M4 M5 M6




CAESAR CREEK
MOVEMENT MARKERS
20' D.S. ℄
HORIZONTAL MOVEMENT

PLATE 43

APPENDIX 1
COFFERDAM CONSTRUCTION



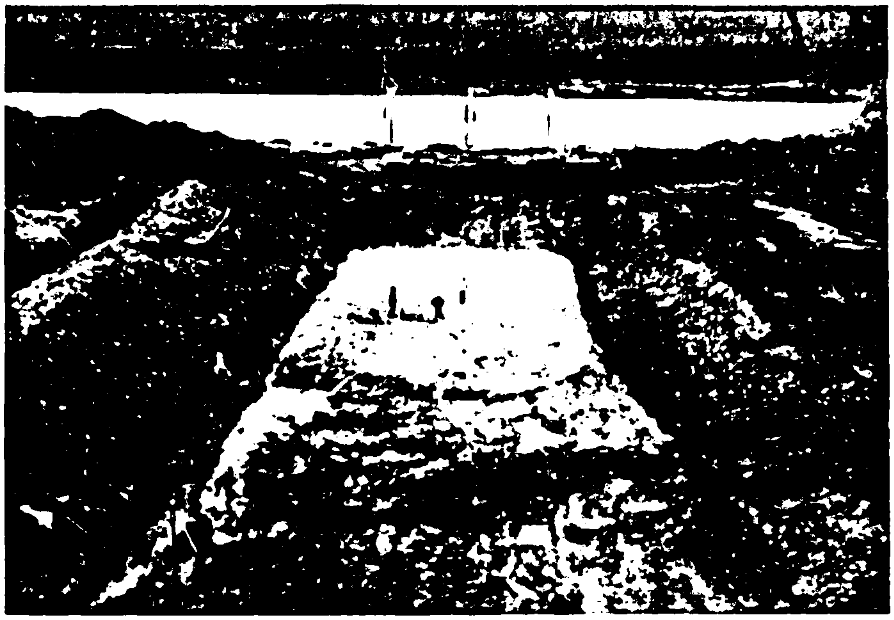
(1) View of left abutment of dam after stripping and prior to diversion 26 September 1973.

(2) View from left abutment showing cofferdam construction with more weather rock being placed in center of embankment Oct 1973.

(3) View looking downstream at completed cofferdam Dec 1973.

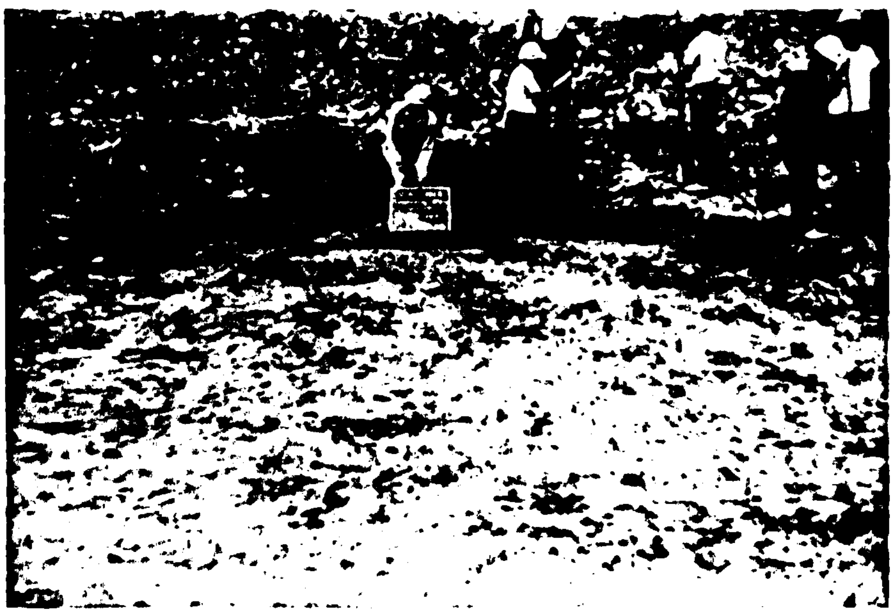
(4) View showing D.S. toe of cofferdam embankment and cleanup of core trench Dec 1973.

DAM FOUNDATION



(5) View showing shale foundation of valley cutoff trench from left abutment Dec 1973.

Impervious Core Embankment Placement - Dam



(6) First lift of impervious material being placed in core area of dam Sep 1974.

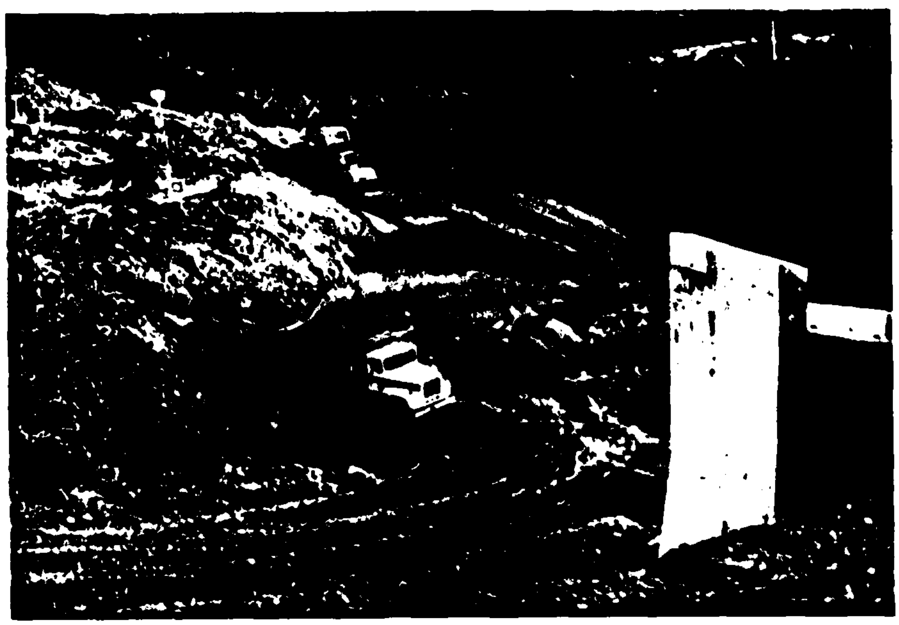
## Impervious Core Embankment

(7) Impervious embankment being placed along left side of conduit, and right abutment toe of dam 17 Sep 1974.

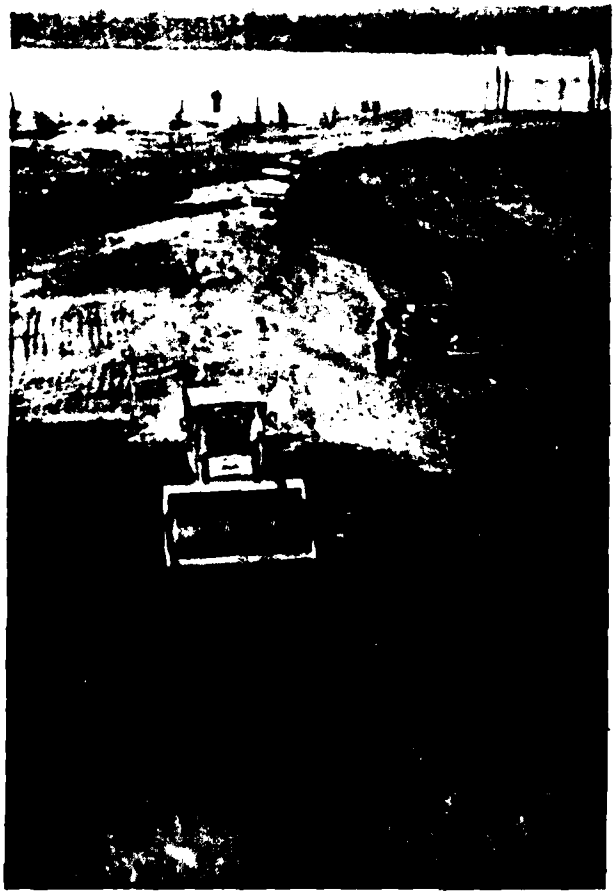
(8) View of impervious placement at left abutment toe of dam 17 Sep 1974.

TRANSITION AND INCLINED DRAIN

(9) View looking at left abutment toe of dam showing beginning of 5 foot wide transition zone and 5 foot wide inclined drain. Material right-hand lower corner of photo is top of original sand and gravel which remained in place. 19 Sep 1974.



(10) Horizontal sand drain being placed at downstream toe of dam. Nov 1974.

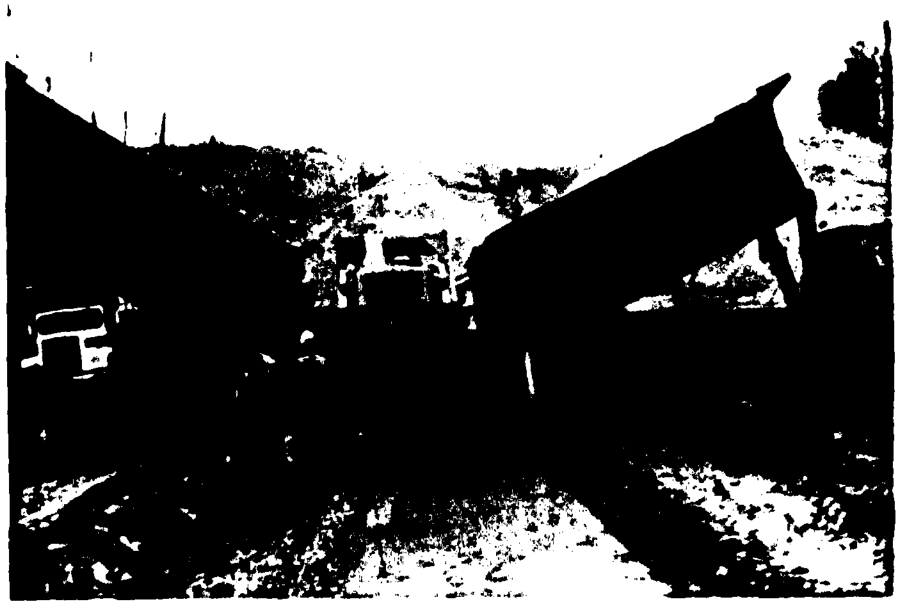


(11) 3 foot thick horizontal sand drain being placed downstream of cutoff trench 1 Oct 1974.

PLACEMENT OF VERTICAL TRANSITION AND INCLINED DRAIN ZONES
Each zone was 5 feet wide

(12) Spreader box built to place two 5 foot zones simultaneously. 17 Apr 1975.

(13) Spray bar and water supply wagon used to add moisture to transition material. June 1975.



(14) Transition and inclined drain materials being dumped into spreader box. April 1975.

(15) View showing overbuilt width of core zone after being cut back to designed edge of zone by a grader. June 1975.

FOUNDATION CLEANUP AND DEWATERING

(16) View showing cleaned foundation prior to impervious placement in left abutment cutoff trench station 17+50, elev. 820. May 1975.

(17) View showing foundation cleanup in right abutment cutoff trench prior to impervious placement. Note dewatering casing upper left of photo. May 1975.


(18) Close view of overburden collection dewatering casing and pump used to keep core area dry. May 1975.

(19) Overview of embankment progress from overlook area Oct 1973.

(20) View looking downstream along right abutment of dam showing impervious core placement. Sep 1974.

(21) View showing lay-out for excavation of D.S. toe drain of dam embankment. Nov 1974.

(22) View looking from left abutment to right abutment showing height of embankment at end of 1974 construction season. Dec 1974.

(23) Aerial view showing construction progress. 1 Feb 1975.

(24) General view of construction operations looking from right abutment. June 1975.

(25) View from right abutment to left abutment across upstream face of dam showing placed riprap. 4 Oct 1975.

DA

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